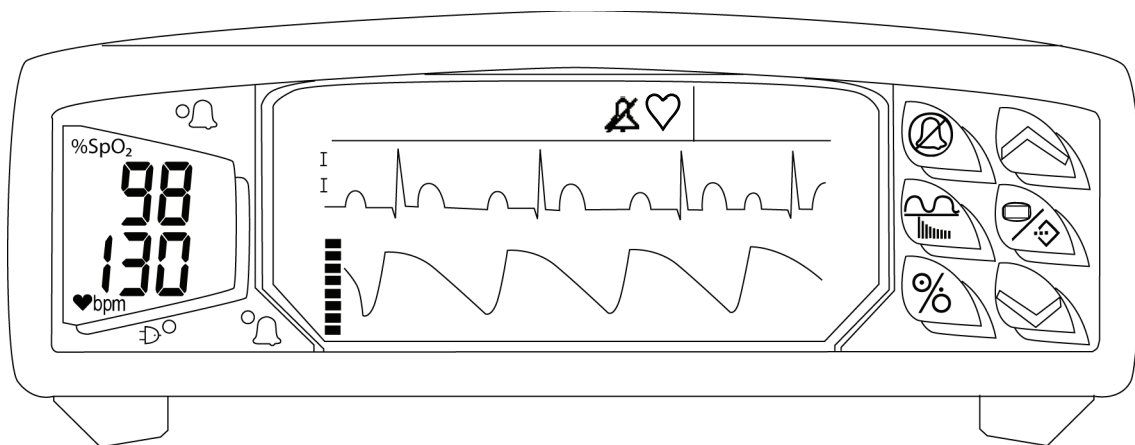


**SurgiVet**<sup>TM</sup>

# **SurgiVet® V3404 ECG/Pulse Oximeter**

## **Operation Manual**



**en** English

Catalog Number V1888

Version 4, September 2007

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The products described are covered by one or more of the following: U.S. Patent No. 5,558,096 and 5,615,091.

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## Warranty and Service Information

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### Proprietary Notice

Information contained in this document is copyrighted by Smiths Medical PM, Inc. and may not be duplicated in full or part by any person without prior written approval of Smiths Medical PM, Inc. Its purpose is to provide the user with adequately detailed documentation to efficiently install, operate, maintain and order spare parts for the device supplied. All information contained in this document is believed to be current and accurate as of the date of publication or revision, but does not constitute a warranty.

### Warranty

#### Limited Warranty

Smiths Medical PM, Inc. ("Seller") warrants to the original purchaser that the Product, not including applicable accessories, shall be free from defects in material and workmanship under normal use, if used in accordance with its labeling, for two years from the date of shipment to the original purchaser.

Seller warrants to the original purchaser that the reusable oximeter sensors supplied as accessories, shall be free from defects in materials and workmanship under normal use, if used in accordance with its labeling, for one year from the date of shipment to the original purchaser (USA only).

Seller warrants to the original purchaser that the AC Power supply/charger supplied, with the exception of part number 3005, shall be free from defects in materials and workmanship under normal use, if used in accordance with its labeling, for 1 year from the date of shipment to the original purchaser (USA only).

Seller warrants to the original purchaser that the reusable temperature cable supplied as accessories shall be free from defects in materials and workmanship under normal use, if used in accordance with its labeling, for 6 months from the date of shipment to the original purchaser (USA only).

Seller warrants to the original purchaser that the reusable ECG leads, reusable invasive pressure cable, reusable NIBP purple hose, disposable temperature probe, disposable invasive pressure transducer and disposable sample lines supplied as accessories, shall be free from defects in materials and workmanship under normal use, if used in accordance with its labeling, for 90 days from the date of shipment to the original purchaser (USA only).

Blood pressure cuffs carry a (6) six month warranty, pending evaluation by Smiths Medical PM, Inc. (SMPM) Veterinary Division Technical Services. Cuffs that are contaminated, have liquid in them, have been misused/abused or are older than (6) months will not be covered under warranty. SMPM, Veterinary Division's sole obligation under this warranty will be to repair or replace, at its option, products that prove to be defective during the warranty period.

The foregoing shall be the sole warranty remedy. Except as set forth herein, seller makes no warranties, either expressed or implied, including the implied warranties of merchantability and fitness for a particular purpose. No warranty is provided if the products are modified without the express written consent of SMPM, Veterinary Division, and seller shall not be liable in any event for incidental or consequential damage. This warranty is not assignable.

Warranties are subject to change. Please contact Smiths Medical PM Inc. Veterinary Division, for current warranty information.

## Loaner Device (Domestic Sales Only)

Smiths Medical PM, Inc. (SMPM) Veterinary Division, will for the period of warranty make available at no charge, loaner devices (domestic sales only) if, in the opinion of SMPM Veterinary Division, the repair of the customer's device would require an unreasonable period of time to repair, and there is a suitable loaner available during the time of the repair.

SMPM Veterinary Division may make available loaner devices, for a fee, should it be requested while an out of warranty device is in for service.

## Disclaimer of Warranties

**THE FOREGOING EXPRESS WARRANTY, AS CONDITIONED AND LIMITED, IS IN LIEU OF AND EXCLUDES ALL OTHER WARRANTIES WHETHER EXPRESS OR IMPLIED, BY OPERATION OF LAW OR OTHERWISE, INCLUDING BUT NOT LIMITED TO, ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.**

Seller disclaims responsibility for the suitability of the Product for any particular medical treatment or for any medical complications resulting from the use of the Product. This disclaimer is dictated by the many elements which are beyond Seller's control, such as diagnosis or patient, conditions under which the Product may be used, handling of the Product after it leaves Seller's possession, execution of recommended instructions for use and others.

## Conditions of Warranty

This warranty is void if the Product has been altered, misused, damaged by neglect or accident, not properly maintained or recharged, or repaired by persons not authorized by Seller. Misuse includes, but is not limited to, use not in compliance with the labeling or use with accessories not manufactured by Seller. This warranty does not cover normal wear and tear and maintenance items.

## Limitation of Remedies

The original purchaser's exclusive remedy shall be, at Seller's sole option, the repair or replacement of the Product. **THIS IS THE EXCLUSIVE REMEDY. In no event will Seller's liability arising out of any cause whatsoever (whether such cause is based in contract, negligence, strict liability, tort or otherwise) exceed the price of the Product, and in no event shall Seller be responsible for consequential, incidental, or special damages of any kind or nature whatsoever, including but not limited to, lost business, revenues and profits.**

## Warranty Procedure

To obtain warranty service or repair of SurgiVet® equipment in the USA, please contact Clinical Support to obtain a Return Authorization Number. Please provide the serial number of all equipment that will be returned. **Any equipment returned for evaluation must be cleaned and decontaminated prior to being handled by our service technicians.** For cleaning instructions, please refer to the appropriate section in the operation manual. If equipment is returned prior to cleaning, and in our opinion it represents a potential biological hazard, the equipment will be returned to the sender as is.

Reference the return authorization number when returning your Product, freight and insurance prepaid by Purchaser, to:

Smiths Medical PM, Inc.	Clinical Support
Veterinary Division	Telephone: 1-262-513-8500
Attn: Repairs / return #	Toll-Free: 1-888-745-6562 (USA only)
N7W22025 Johnson Drive	Fax: 1-262-513-9069
Waukesha, WI 53186	Web: <a href="http://www.surgivet.com">www.surgivet.com</a>

Seller will not be responsible for unauthorized returns or for loss or damage to the Product during the return shipment. The repaired or replaced Product will be shipped, freight prepaid by Seller, to Purchaser.

To obtain warranty information outside the USA, contact your local distributor.

**NOTE! Shipments received without a return number will be returned to sender.**

Keep all original packing material, including foam inserts. If you need to ship the device, use only the original packaging material, including inserts. Box and inserts should be in original condition. If original shipping material in good condition is not available, it should be purchased from Smiths Medical PM, Inc. Veterinary Division.

Damages occurred in transit in other than original shipping containers are the responsibility of the shipper. All costs incurred returning devices for repair are the responsibility of the shipper.

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


# Chapter 1: Introduction








## About this Manual

The Operation Manual provides installation, operation, and maintenance instructions for veterinary health-care professionals and other users, trained in monitoring veterinary activity.

**These instructions contain important information for safe use of the product. Read the entire contents of these Instructions For Use, including Warnings and Cautions, before using this monitor. Failure to properly follow warnings, cautions and instructions could result in death or serious injury to the patient.**

## Definition of Symbols

SYMBOL	DEFINITION
	Caution: Federal (U.S.A.) law restricts this device to sale by or on the order of a licensed veterinarian.
	Attention, see instructions for use.
	Refer servicing to qualified service personnel
	Defibrillator-proof type CF equipment
	Type CF equipment
	Class II device
	Direct Current
	Output voltage
	Input voltage
	Use by
	Date of Manufacture
	Non AP Device
	Do not reuse. One use on one patient.
	Collect Separately
IPX1	Drip Proof (monitor only)
	Moisture Sensitive
%	Standby/ON
	Wave/Trend
	Menu/Enter
	Up and Down Arrows

SYMBOL		DEFINITION	
		ALARM SILENCE	
		Printer output	
		Loudspeaker	
		Charge LED (green)	
		High (red) or Low (yellow) priority alarm LED	
		Heart Rate LED	
		Oxygen Saturation LED	
KEYWORD		DEFINITION	
<b>WARNING!</b>		Tells you about something that could hurt the patient or hurt the operator.	
<b>CAUTION!</b>		Tells you about something that could damage the monitor.	
<b>NOTE!</b>		Tells you other important information.	

## General Warnings, Cautions and Notes

**WARNING!** Do not use this device in the presence of flammable anesthetics.

**WARNING!** ELECTRICAL SHOCK HAZARD when cover is removed. Do not remove covers. Do not disassemble unit. Unit not user serviceable. ⚠️ Refer servicing to qualified personnel.

**WARNING!** Do not use this device in the presence of magnetic resonance imaging (MR or MRI) equipment.

**WARNING!** Operation of this device may be adversely affected in the presence of computed tomograph (CT) equipment.

**WARNING!** Do not plug the monitor into an outlet controlled by a wall switch.

**WARNING!** This monitor is NOT for use in the home.

**WARNING!** This device is intended for use by persons trained in professional health care. The operator must be thoroughly familiar with the information in this manual before using the monitor.

**WARNING!** This device must be used in conjunction with clinical signs and symptoms. This device is only intended to be an adjunct in patient assessment.

**WARNING!** If the accuracy of any measurement is in question, check the patient's vital sign(s) by an alternative method and then check the monitor for proper functioning.

**WARNING!** The monitor should not be used in the presence of electrosurgical equipment. The device has no protective mechanisms to prevent patient burns when used with high frequency surgical equipment.

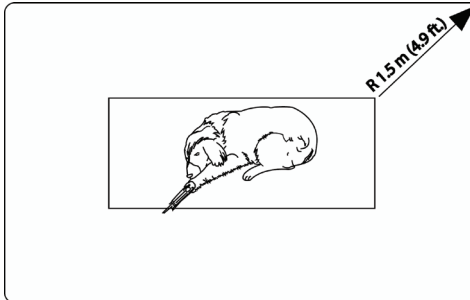
**WARNING!** Equipment is protected against defibrillator discharge. Rate meters and displays may be temporarily affected during defibrillation, but will rapidly recover.

**WARNING!** The monitor is protected against damage from defibrillator, diathermy, and electrocautery discharge.

**WARNING!** Where HF (diathermy) is used there is no danger of burning to the patient provided recommended components are used. Rate meters may be temporarily affected.

**WARNING!** The vital signs monitor is suitable for use within the patient environment IEC 60950 approved equipment must be placed outside of the patient environment. The patient environment is defined as any volume in which intentional or unintentional contact can occur between the patient and parts of the system or between the patient and other persons touching parts of the system.

Figure 1.1: Patient Environment (Dimensions are not prescriptive)



**WARNING!** When connecting this monitor to any instrument, verify proper operation before clinical use. Refer to the instrument's user manual for full instructions. Accessory equipment connected to the monitor's data interface must be certified according to the respective IEC standards, i.e., IEC 950 for data-processing equipment or IEC 601-1 for electromedical equipment. All combinations of equipment must be in compliance with IEC 601-1-1 systems requirements. Anyone connecting additional equipment to the signal input port or signal output port configures a medical system, and, therefore, is responsible that the system complies with the requirements of the system standard IEC 601-1-1.

**WARNING!** In the event that earth ground integrity is lost, the performance of this device and/or other devices nearby may be affected due to excessive RF emissions.

**WARNING!** The monitor should be operated from its internal power source (if fitted) if the integrity of the protective earth conductor is in doubt.

**WARNING!** Any monitor that has been dropped or damaged should be checked by a qualified service personnel to insure proper operation prior to use.

**WARNING!** This monitor will not operate effectively on patients who are experiencing convulsions or tremors.

**WARNING!** Patient safety can be compromised by the use of a power supply not supplied by Smiths Medical PM, Inc. Use only the power supply included with your monitor, or one approved by Smiths Medical PM, Inc.

**WARNING!** Ensure the device's AC rating is correct for the AC voltage at your installation site before using the monitor. The monitor's AC rating is shown on the external power supply. If the rating is not correct, do not use the monitor; contact Smiths Medical PM, Inc. Veterinary Division service department for help.

**WARNING!** Ensure conductive parts including electrodes of the patient cable do not come into contact with any conductive surfaces or earth parts.

- WARNING!** Disconnect the AC power supply from the outlet before disconnecting it from the monitor. Leaving the AC power supply connected to an AC power outlet without being connected to the monitor may result in a safety hazard.
- WARNING!** Do not allow any moisture to touch the AC power supply connectors or a safety hazard may result. Ensure that hands are thoroughly dry before handling the AC power supply.
- WARNING!** Do not place the monitor in the patient's bed or enclosure. Do not place the monitor on the floor.
- WARNING!** Failure to place the monitor away from the patient may allow the patient to turn off, reset, or damage the monitor, possibly resulting in the patient not being monitored. Make sure the patient cannot reach the monitor from their bed or enclosure.
- WARNING!** Failure to carefully route the cable from the sensor to the monitor may allow the patient to become entangled in the cable, possibly resulting in patient strangulation. Route the cable in a way that will prevent the patient from becoming entangled in the cable. If necessary, use tape to secure the cable.
- WARNING!** If there is a risk of the AC power supply becoming disconnected from the monitor during use, secure the cord to the monitor several inches from the connection.
- WARNING!** It is the operator's responsibility to set alarm limits appropriately for each individual patient.
- WARNING!** Verify the functionality of any remote alarm system connected to this monitor before leaving the patient unattended.
- WARNING!** Verify that all LEDs (light emitting diodes) on the display light up upon startup of the device.
- WARNING!** Do not autoclave, ethylene oxide sterilize, or immerse in liquid. Unplug before cleaning or disinfecting.
- CAUTION!** Pressing front panel keys with sharp or pointed instruments may permanently damage the keypad. Press front panel keys only with your finger.
- CAUTION!** Should the device become wet, wipe off all moisture and allow sufficient time for drying before operating.
- CAUTION!** Do not allow water or any other liquid to spill onto the monitor. Unplug the external power supply from the monitor before cleaning or disinfecting the monitor. Evidence that liquid has been allowed to enter the monitor voids the warranty.
- CAUTION!** Follow local governing ordinances and recycling instructions regarding disposal and recycling of device components.
- CAUTION!** The monitor contains a 1.2 hour lead-acid battery. If the battery fails to hold a charge or otherwise become inoperable, the battery should be replaced and the old battery should be disposed of properly. Lead-acid batteries should not be disposed of in normal trash containers. They should be sent to the proper facilities so that the metals in them may be reclaimed and/or recycled.
- LEAD-ACID battery:** In the US, 1-800-822-8837 will provide information about the proper disposal of the lead-acid battery. Regulations in Europe vary from country to country. Consult local authorities for information about proper disposal. Smiths Medical PM, Inc. Veterinary Division cannot dispose of monitor batteries.



**CAUTION!** Chemicals used in some cleaning agents may cause brittleness of plastic parts. Follow cleaning instructions in this manual.

**NOTE:** All user and patient accessible materials are non-toxic.

**NOTE:** Each input and output connection of the monitor is electrically isolated. Connection of this monitor to other equipment will not increase leakage current.

**NOTE:** If menus are shown and you do not press a menu key for 20 seconds, the waveform display will return, excluding the analog out menu, and any current menu selections will be accepted.

**NOTE:** The battery is intended to be used in backup situations only. Battery life will decrease prematurely if not properly utilized. The monitor should be used with AC power as often as possible.

## **Oximetry Warnings, Cautions and Notes**

**WARNING!** Use only SpO<sub>2</sub> sensors supplied with, or specifically intended for use with, this device.

**WARNING!** Incorrectly applied sensors may give inaccurate readings. Refer to the sensor insert for proper application instructions.

**WARNING!** Prolonged use or the patient's condition may require changing the sensor site periodically. Change sensor site and check skin integrity, circulatory status, and correct alignment at least every 4 hours.

**WARNING!** When attaching SpO<sub>2</sub> sensors with Microfoam<sup>®</sup> tape, do not stretch the tape or attach the tape too tightly. Tape applied too tightly may cause inaccurate readings and blisters on the patient's skin (lack of skin respiration, not heat, causes the blisters).

**WARNING!** Dyes introduced into the bloodstream, such as methylene blue, indocyanine green, indigo carmine, patent blue V (PBV), and fluorescein, may adversely affect the accuracy of the SpO<sub>2</sub> reading.

**WARNING!** Any condition that restricts blood flow, such as use of a blood pressure cuff or extremes in systemic vascular resistance, may cause an inability to determine accurate pulse and SpO<sub>2</sub> readings.

**WARNING!** Significant levels of dysfunctional hemoglobins, such as carboxyhemoglobin (with CO-poisoning) or methemoglobin (with sulfonamide therapy), will adversely affect the accuracy of the SpO<sub>2</sub> measurement.

**WARNING!** SpO<sub>2</sub> measurements may be adversely affected in the presence of high ambient light. If necessary, shield the sensor area (with a surgical towel, for example).

**WARNING!** Optical cross-talk can occur when two or more sensors are placed in close proximity. It can be eliminated by covering each site with opaque material.

**WARNING!** Tissue damage may result from overexposure to sensor light during photodynamic therapy with agents such as verteporphin, porfimer sodium and meta-tetrahydroxyphenylchlorin (mTHPC). Change the sensor site at least every hour and observe for signs of tissue damage. More frequent sensor site changes or inspections may be indicated depending upon the photodynamic agent used, agent dose, skin condition, total exposure time or other factors. Use multiple sensor sites.

**WARNING!** Under certain clinical conditions, pulse oximeters may display dashes if unable to display SpO<sub>2</sub> and/or pulse rate values. Under these conditions, pulse oximeters may also display erroneous values. These conditions include, but are not limited to: patient motion, low perfusion, cardiac arrhythmias, high or low pulse rates or a combination of the above conditions. Failure of the clinician to recognize the effects of these conditions on pulse oximeter readings may result in patient injury.

**NOTE:** The low SpO<sub>2</sub> alarm limit minimum test value is 80. If an operator changes the low SpO<sub>2</sub> alarm limit to a value less than 80, and a power down - power up sequence takes place, a minimum value of 85 takes the place of the operator entered value.

**NOTE:** SpO<sub>2</sub> averaging is the number of pulse beats over which the SpO<sub>2</sub> value is averaged; pulse averaging is the number of seconds over which the pulse value is averaged.

## ECG Warnings, Cautions and Notes

**WARNING! PACEMAKER PATIENTS.** Rate meters may continue to count the pacemaker rate during occurrences of cardiac arrest or some forms of arrhythmia. Do not rely entirely upon rate meter alarms. Keep pacemaker patients under close surveillance. See this manual for disclosure of the pacemaker pulse rejection capability of this instrument.

**WARNING! PACEMAKER PATIENTS:** If PACE DETECT is not turned on when monitoring pacemaker patients the heart rate readouts derived from the ECG patient connections are likely to display erroneous high or erratic rates. Keep pacemaker patients under close surveillance. For pacemaker patients it may be advisable to select the SpO<sub>2</sub> parameter as the primary heart rate source.

**WARNING!** Connect only three-lead or five-lead ECG lead wires from the patient to the ECG patient cable. Do not connect any other signal source to the ECG patient cable.

**WARNING!** False low heart rate indicators or false Asystole calls may result with certain pacemakers because of electrical overshoots.

**WARNING!** Reliable monitoring of pacemaker patients can only occur with the pace detect on.

**WARNING!** The pacemaker spike shape and size is not to be diagnostically interpreted.

**WARNING!** Keep pacemaker patients under close observation. Rate detection in the software may continue to count the pacemaker rate during cardiac arrest and/or arrhythmia conditions. Therefore, do not rely solely on rate detection alarms.

**WARNING!** Do not use line isolations transformers with this monitor. Line isolation monitor transients may resemble actual cardiac waveforms and thus inhibit heart rate alarms.

**WARNING!** Electrodes of dissimilar metals should not be used.

**NOTE:** Follow institutional standards when applying ECG electrodes. Silver/Silver Chloride disposable electrodes are strongly recommended to avoid polarization effects that result in large input offset potentials. Use of "squeeze bulb" type electrodes is not recommended.

**NOTE:** Use only standard AAMI three-lead or five-lead ECG cables.

**NOTE:** The ECG patient circuit is electrically isolated.

## Chapter 2: Description of Measurements, Controls and Features

### Intended Use

The SurgiVet® V3404 ECG/Pulse Oximeter is a low cost portable ECG and oximetry monitor. It noninvasively and continuously monitors and displays arterial blood oxygen saturation of arterial hemoglobin (SpO<sub>2</sub>), pulse rate, plethysmogram and ECG waveforms. It may be used in the veterinary hospital or clinical environment. The oximetry feature works with all SurgiVet® oximetry sensors, providing SpO<sub>2</sub> and pulse rate on all patients. The SurgiVet® V3404 ECG/Pulse Oximeter permits continuous patient monitoring with adjustable alarm limits for oximetry and ECG, as well as visible and audible alarm signals.

### General Description

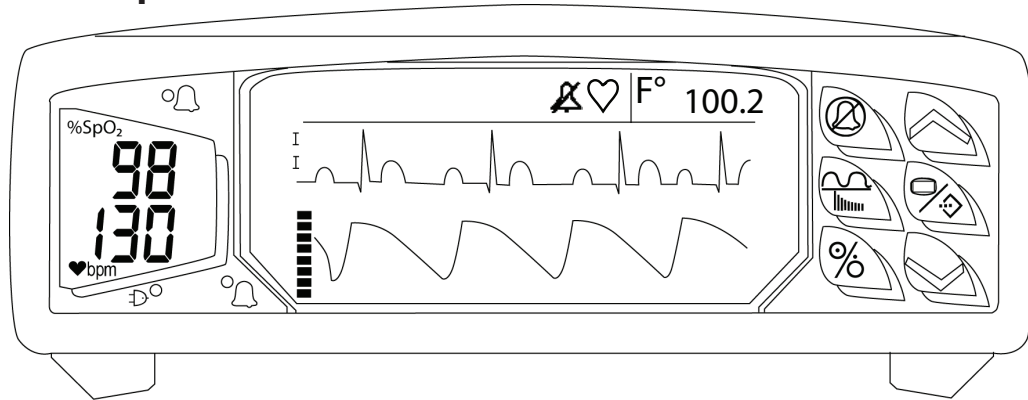


Figure 2.1: General Description

### Parameters

The SurgiVet® V3404 ECG/Oximeter is an ECG and oximetry monitor. Alarm limits can be set on all monitored parameters.

### ECG

The monitor continuously measures and displays an ECG waveform. Either 3 or 5 lead monitoring may be selected. The monitor beeps with each heartbeat. The volume of the heartbeat is adjustable. The pitch of the heartbeat varies with the heart rate value.

### Oximeter

The monitor continuously measures and displays arterial blood oxygen saturation (SpO<sub>2</sub>) and Pulse Rate (HR). Oximetry includes the display of a plethysmogram and pulse strength bar. The monitor beeps with each pulse beat. The volume of the pulse beep is adjustable. The pitch of the pulse beep varies with the SpO<sub>2</sub> value. A variety of veterinary reusable sensors are available for monitoring patients.

### Audio

The monitor uses a multi-frequency speaker for beeps and alarm/alert sounds. Volumes are adjustable.

### Serial Output

An RS-232C interface allows serial output of text data to either a PC or a compatible serial printer. Waveforms may be output only if the monitor is attached to an optional BCI® graphics printer.

### Analog Outputs

There are two analog channels with user-selectable outputs of waveform or parameter data, or calibration signals.

### Power

The SurgiVet® V3404 operates on power from an external power supply. In addition, the monitor contains an internal battery which will allow operation for approximately 1.5 hours. However, the monitor should remain on the external power supply whenever possible.

## Front Panel

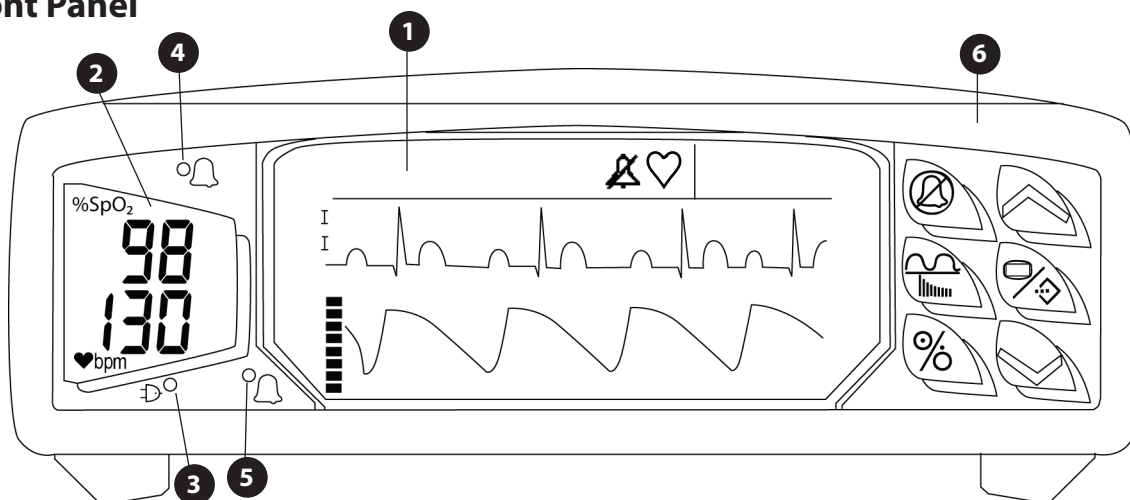


Figure 2.2: Front Panel

### 1 EL Panel

The electroluminescent display (EL) provides continuous, real-time updates of one or two waveforms or measurement trends, and alarm or alert messages. The display also shows menus and a pulse strength bar.

### 2 Display LED's

The display LED's provide continuous, real-time updates of oximetry values: % SpO<sub>2</sub> and pulse rate (♥bpm). If the ♥bpm source is set to ECG in the SETUP/VOLUME menu, the display LED for ♥bpm will show a heart rate value.

### 3 Charge LED(green)

Is on steady while external power is applied and battery is fully charged. Indicates battery is charging by blinking very slowly while external power is applied. If there is no external power, then this LED is off.

### 4 HIGH PRIORITY ALARM LED (red)

This ALARM indicator flashes during patient alarms.

### 5 LOW PRIORITY ALARM LED (yellow)

This ALARM indicator flashes during a system alarm, but remains on steady if there is no system alarm and a low battery condition exists.

### 6 Keys

The front panel keys control the monitor's functions. Dedicated keys are provided for turning the monitor on and off, silencing alarm and alert tones, selecting waveforms or trends, and selecting menus.

## EL Display

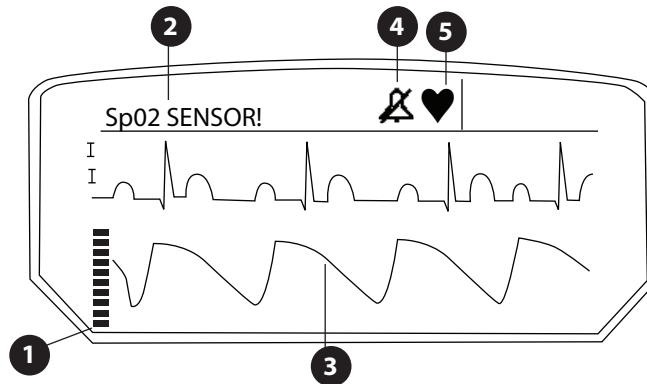


Figure 2.3: EL Display

### 1 Pulse Bargraph

The pulse signal strength is displayed here on a 10 segment bargraph.

### 2 Message Area

Messages for alarms, alerts, and system information are displayed here on two lines. If more than one message must be displayed on the same line, then they alternate once per second.

### 3 Waveforms Trends, Menus

One or two waveforms are displayed here. A trend graph or a menu can be displayed in place of waveforms.

### 4 Alarm Silence Indicator

Flashes during two-minute alarm silence. Stays on steady during indefinite alarm silence. If alarms are not silenced the indicator stays on steady and appears without the slash.

### 5 ECG/Pulse Rate Indicator

This heart icon blinks with each heart beat.

## Keys

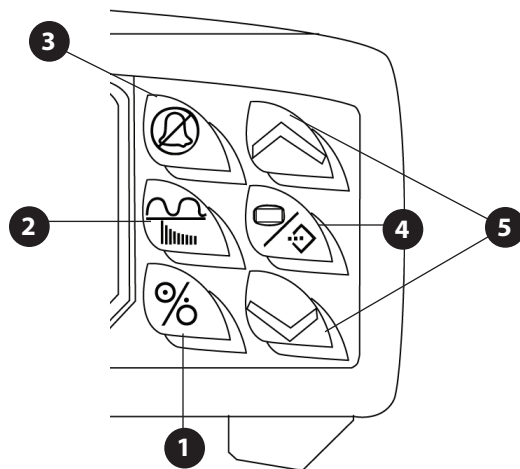














Figure 2.4: Keys

- 1 % STANDBY/ON**  
Pressing % switches the monitor between ON (monitoring a patient) and STANDBY (monitor off, but power is applied if the green indicator is lit.).
- 2  WAVE/TREND**  
This key controls the waveform area display. Press this key to display the ECG wave by itself, the plethysmogram by itself, or both ECG and the oximeter's plethysmogram, or a trend. Press  while menus are displayed for a quick menu exit. The waveform or trend previously displayed will replace the menu.
- 3  ALARM SILENCE**  
Pressing  disables the audible alarm tone for two minutes. (The Alarm Silence indicator on the EL display flashes.) Pressing and holding this key for about three seconds disables the alarm tone indefinitely. (The Alarm Silence indicator on the EL Display is lit and not flashing. The indicator appears with a slash through it.) Pressing this key momentarily cancels either alarm silence condition. The monitor defaults to two minute alarm silence at power up.
- 4  MENU/ENTER**  
Press this key to display the list of menus. While menus are displayed, press  to select a menu item or to accept a value that has been adjusted.
- 5   ARROWS**  
If a Menu is displayed, press the UP/DOWN ARROWS (   ) to move among menu items or to adjust the value of a selected item. If a Trend is displayed, the ARROW (   ) keys cycle between trended parameters.

## Side Panel

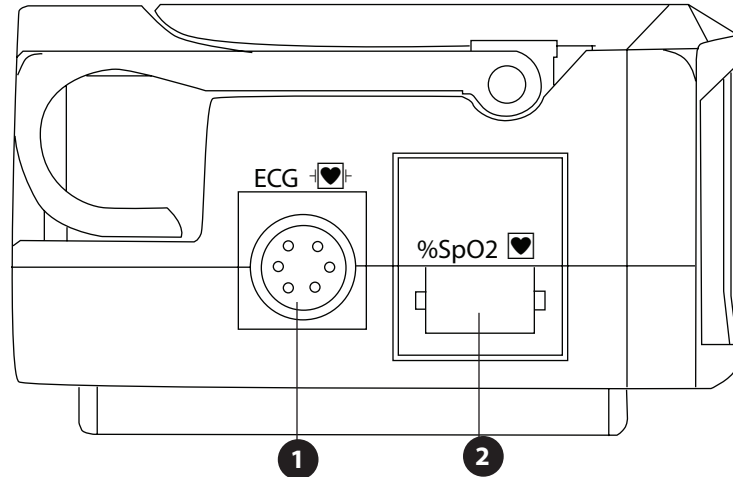


Figure 2.5: Side Panel

### 1 ECG Connector

The ECG cable is connected here.

### 2 %SpO<sub>2</sub> Connector

The oximetry sensor patient cable is connected here.

## Rear Panel

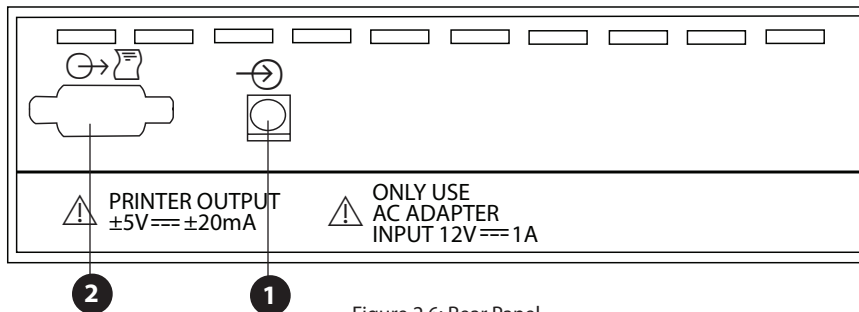


Figure 2.6: Rear Panel

### 1 Power Input

The external power supply attaches to this connector.

**NOTE:** Connect the AC charger to the AC power connector of the monitor first and then the AC charger to the wall outlet second.

1617	Charger, AC 105-125V, 60 Hz
1618	Charger, AC 208-264V, 50/60 Hz
1619	Charger, AC 90-110V, 50 Hz

**WARNING!** Disconnect the AC power supply from the outlet before disconnecting it from the monitor. Leaving the AC power supply connected to an AC power outlet without being connected to the monitor may result in a safety hazard.

**WARNING!** Do not allow any moisture to touch the AC power supply connectors or a safety hazard may result. Ensure that hands are thoroughly dry before handling the AC power supply.

**WARNING!** If there is a risk of the AC power supply becoming disconnected from the monitor during use, secure the cord to the monitor several inches from the connection.

**CAUTION!** Ensure the device's AC rating is correct for the AC voltage at your installation site before using the monitor. The monitor's AC rating is shown on the external power supply. If the rating is not correct, do not use the monitor; contact Smiths Medical PM, Inc. Veterinary Division service department for help.

## **2 Digital/ Analog Outputs**

An external RS-232C communication device can be connected to the monitor through this port. Use printer cable (catalog #V3361) to attach to a printer or cable (catalog #V3365) to attach to a computer's serial port.

Analog signals representing ECG waveform, plethysmogram, pulse rate, and SpO<sub>2</sub> are routed to this connector for use with chart recorders and similar devices.





## Chapter 3: Setting Up the Monitor

### Unpacking the Monitor and Checking the Shipment




Carefully remove the monitor and accessories from the shipping carton. Save the packing materials in case the monitor or accessories must be shipped or stored. Compare the packing list with the accessories received to make sure the shipment is complete.

### Turning High and Low Priority Alarm Tones On and Off

When the monitor is turned on, the alarm tones are silenced for two minutes. The Alarm Silence indicator (  ) on the EL display, flashes during the two minute time-out.

- To silence the alarm tones indefinitely: Press and hold  for about three seconds; the Alarm Silence indicator lights steady.

**NOTE:** To comply with government requirements for patient monitoring, the indefinite alarm and alert tone silence feature may not be available in monitors shipped to your country.

- To silence the alarm tones for two minutes: Momentarily press  the Alarm Silence indicator flashes. If tones are already silenced, press  twice (the first press cancels alarm silenced; the second press silences the alarms for two minutes).
- To cancel either two minute or indefinite alarm silence and enable alarm and alert tones: Momentarily press , the Alarm Silence indicator turns off.

### Working With Menus

#### Menu Structure

##### Alarm Limits

Set ECG High and Low Alarms  
Set SpO2 High and Low Alarms  
Set Pulse Rate High and Low Alarms

##### Trends

Select Display Time  
Select Trend Display Scales for Each Parameter  
Clear Trend Memory

##### Setup/Volume

Select Waveform Sweep Speed  
Select BPM Source  
Adjust Alarm Volume  
Adjust Pulse Volume

##### Analog Out

Assign Data/Waveform Output to Each of 2 Channels  
Assign 1V Cal Signal  
Assign 0V Cal Signal

##### ECG




Select Lead  
Select Size  
Enable/Disable Pace Detect  
Select Number of Leads  
Select the ECG Detection Threshold  
Enable/Disable ECG Monitor Function










##### Serial Out

Start/Stop Serial Output  
Enable/Disable Nurse Call  
Select Data Format  
Select Printer Type  
Select Print Interval or Duration  
Select Sweep Speed

##### Oximeter


Select Averaging Parameters  
Disable/Enable Oximeter Function

The operator chooses various monitor settings through menus that appear in the waveform area. The  key and ARROW keys ( ) are used to select menu items and change settings.

1. To show the Main menu: Press the  key. Menus replace any waveforms displayed.
2. To select a menu item: Press the ARROW keys ( ) until the selector arrow points to the desired item, then press . This will either take you to a new menu or allow the selected item to be adjusted.
3. To change a setting for a selected menu item: After pressing  as in step 2, the item that can be changed will be highlighted. Use the ARROW keys ( ) to select the desired setting, then press  to accept that setting.
4. To exit the current menu: Select the **[EXIT]** menu item
5. To exit all menus quickly and return to the previous monitoring screen: Press .

**NOTE:** If menus are shown and you do not press menu keys for 20 seconds, the waveform display will return, and any current menu selections will be accepted.

## Freezing and Releasing Displayed Waveforms

Displayed waveforms, except trends, can be frozen and released quickly. To freeze or release waveforms, press the  key twice (x2).

- The first key press displays the Main Menu.
- The second key press selects the first item in the Main Menu, which is **"FREEZE WAVE"**. This automatically exits to the waveform screen to show the results.
- If waveforms are already frozen, **"FREEZE WAVE"** allows them to update again.

**NOTE:** While waveforms are frozen, the message **"Waves Frozen"** is shown in the message area at the top of the display (subject to message priority.)

**NOTE:** Trends are not affected by the waveform freeze feature. Trends continue to be collected while the waveforms are frozen.

**NOTE:** Analog outputs are not affected by the waveform freeze feature. If waveforms are selected for the analog output channels, then waveform data will continue to be output while the displayed waveforms are frozen.

**NOTE:** Displayed numeric values are not affected by the waveform freeze feature. The numeric values continue to be updated and displayed while the displayed waveforms are frozen.

## Working With System-Wide Settings

This section describes working with system-wide settings using the **SETUP/VOLUME** menu.

### Setup/Volume Menu

The following system-wide settings are viewed and/or adjusted from the Setup/Volume menu:

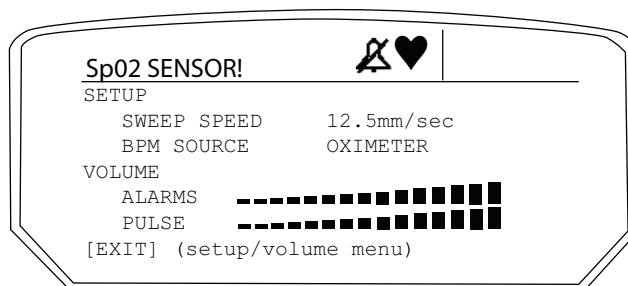


Figure 3.1: Setup Menu

### SETUP

The waveform sweep speed can be set for fast (25 mm/sec) and slow (12 mm/sec) speeds. The heart rate source can be set to either Oximeter or ECG.

### VOLUME

Indicates the Alarm and Pulse volume. Allows the volume to be adjusted in the range of 1 to 15. Pulse volume can be set to OFF. Alarm volume can not be shut off.






### Turning Parameter Monitoring On and Off

Monitoring for the following parameters can be turned on or off:

- ECG (ECG waveform, heart rate)
- Oximeter (Plethysmogram, SpO<sub>2</sub>%, pulse rate, pulse strength)

When turned off, displays, indicators, and alarms related to the parameter are disabled. The parameter occupies a space on the display and in the serial output, but its value is shown as dashes (---). If the parameter is assigned to an analog channel, that channel shows 0 Volts. If a parameter has a waveform, its waveform area shows a monitor off message.

To turn a parameter's monitoring on or off, do the following:

1. From the Main menu, select the desired parameter's menu item: **ECG** or **OXIMETER**.
2. In the parameter's menu, select the monitor **on/off** item.
3. Press  and use the ARROWS (   ) to adjust the setting.
4. Press the  key to accept the setting.
5. Select **[EXIT]** or press  to exit menus.





## Adjusting Waveform Sweep Time, Size or Scales

The sweep time, height, and scales for waveforms can be adjusted as follows:

1. The ECG waveform sweep speed can be adjusted in the **SETUP/VOLUME** menu. The waveform scale can be adjusted in the **ECG** menu.
2. The Plethysmogram sweep speed can be adjusted in the **SETUP/VOLUME** menu. The waveform is scaled automatically to fit the display area.
3. Each parameter's trend display scales can be adjusted separately through the **TRENDS, SCALES** menu.

## Adjusting the Line Filter Parameter

The line filter needs to be adjusted based on the frequency of the line voltage being supplied to the monitor. For 50Hz line voltage frequency, select the 50Hz line filter option. For the 60Hz line voltage frequency, select the 60Hz line filter option. The line filter frequency can be adjusted as follows:

1. Press the Wave/Trend key  and the Menu/Enter key  simultaneously to enter the service mode.
2. Use the ARROW (   ) keys to select the line filter option.
3. Select the frequency that matches the input line voltage frequency.

## Chapter 4: Alarms

### High Priority Alarms

A *high priority alarm* warns you when a patient's measurement matches or exceeds the high or low alarm limit for that measurement. For example, if the low SpO<sub>2</sub> alarm limit is set to 92, and the patient's measured SpO<sub>2</sub> is 90, a high priority alarm is triggered. During a high priority alarm:

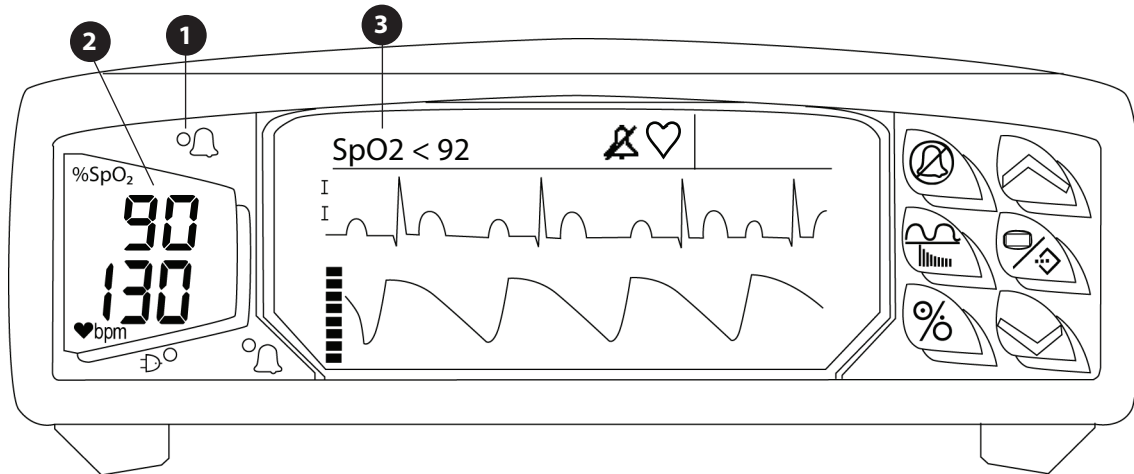


Figure 4.1: Alarm Example

- 1 The High Priority ALARM indicator flashes (red).
- 2 The digits for the violated alarm limit flash.
- 3 A message is displayed (will alternate with other messages).

**The High Priority Alarm tone sounds (if not silenced).**

**NOTE:** The alarm actions occur for each violated alarm, even if more than one alarm is violated at the same time.

## Low Priority Alarms

A *low priority alarm* warns you about a condition that prevents the monitor from taking a measurement. For example, if the SpO<sub>2</sub> sensor is not connected to the monitor, the monitor cannot measure the patient's pulse rate or SpO<sub>2</sub> value. In this case, a low priority alarm is triggered. During a low priority alarm:

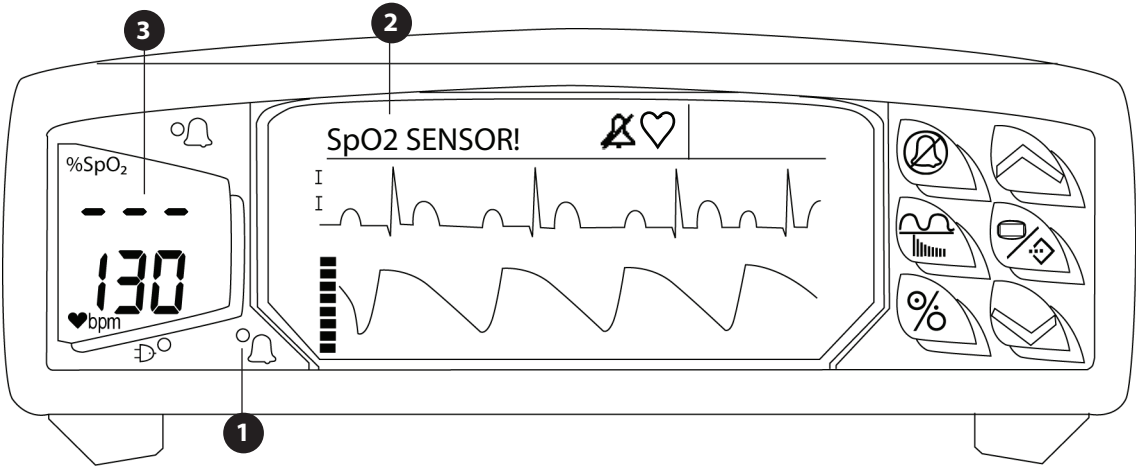


Figure 4.2: Low Priority Alarm Example

- 1 The low priority alarm LED (yellow) flashes.**
  - 2 A message is shown on the display (will alternate with other messages).**
  - 3 Dashes indicate the measurement is unavailable.**
- The low priority alarm tone sounds (if not silenced).**

## Working With the Alarms Menu

This section describes working with alarms using the ALARMS menu. For information on the parameter menus, refer to the chapter of the manual that describes the parameter.

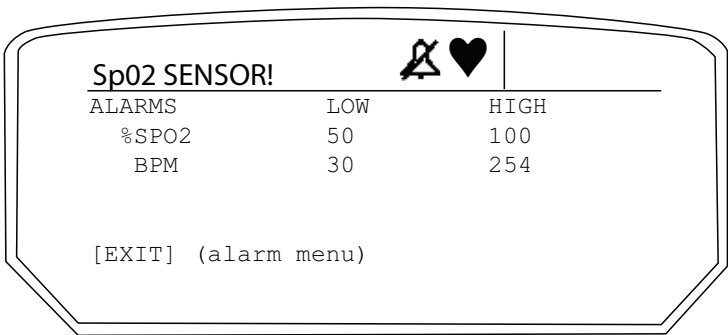






Figure 4.3: Alarm Limits Menu

### LOW and HIGH

Indicates the low and high alarm limit for each measurement. Allows the alarm limits to be adjusted.

## Adjusting or Viewing Alarm Limits

1. From the Main menu, select the **ALARMS** item.
2. Using the ARROW keys (   ), select the alarm limit to be changed under the **LOW** or **HIGH** column.
3. Press the  key to highlight the value. Use the arrow keys to adjust the value. Press the  key to set the value.
4. Select **[EXIT]** or press the a key to exit menu.

**NOTE:** Alarm limits are saved through power cycles, with the exception of the following note.

**NOTE:** If the operator changes the low SpO<sub>2</sub> alarm limit to a value less than 80, and a power down-power up sequence takes place, a minimum value of 85 takes the place of the operator's entered value.

**NOTE:** Alarms may be tested while the monitor is in use by setting alarm limits such that the measured parameter is outside the alarm limits. Be sure to restore alarm limits to required settings after testing.


## Alarm Tones



The high priority alarm tone is a three-tone burst with a pause followed by a two-tone sound (beep beep-beep pause beep-beep). The tone for low priority alarms is a two-tone sound with a pause (beep-beep, pause, beep-beep).

- The high and low priority alarm tones sound at the same volume.
- The volume can be adjusted in the **SETUP/VOLUME** menu.
- The volume can not be set to OFF.
- All alarm tones can be silenced.

**NOTE:** Information signals, i.e. Low Battery, cannot be silenced.






## Turning Alarm Tones On and Off

When the monitor is turned on, the alarm tones are silenced for two minutes. The Alarm Silence indicator (  ) on the EL Display flashes during the two minute time-out.

- To silence the alarm tones indefinitely: Press and hold  for about three seconds; the Alarm Silence indicator (  ) lights steady.


**NOTE:** To comply with government requirements for patient monitoring, the indefinite alarm tone silence feature may not be available in monitors shipped to your country.

**NOTE:** To comply with government requirements for patient monitoring, the indefinite alarm tone silence feature may be turned off. For more information on turning the permanent silence feature on and off, please see the Permanent Silence Section below.





- To silence the alarm tones for two minutes: Momentarily press ; the Alarm Silence indicator (  ) flashes. If tones are already silenced, press  twice (the first press cancels alarm silenced; the second press silences the alarms for two minutes).
- To cancel either two minute or indefinite alarm silence and enable alarm tones: Momentarily press ; the Alarm Silence indicator (  ) lights steady and the slash is removed.

## System Information Signal: Low Battery

A low battery condition will be detected when the battery has about 10 minutes remaining. As soon as the condition is detected:

- The message “**LOW BATTERY**” is displayed on the second message line. It alternates with other messages at once per second.
- This message remains displayed until the monitor is connected to power.
- The low priority alarm LED is lit.
- A unique tone, a burst of 5 beeps, sounds as soon as the low battery condition is detected, and every 30 seconds thereafter while the condition persists.
- The volume of the low battery tone is equal to, or greater than, the alarm volume setting.
- The low battery audible cannot be disabled by the  key.

## Permanent Silence

When the monitor is turned on, simultaneously press the Wave/Trend  and Menu/Enter  keys to enter the Service Mode. Use the ARROW (   ) keys to toggle between **YES** and **NO** (enabled or disabled).



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## Chapter 5: ECG

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### Theory of Operation

Electrical currents influenced by the cardiac impulse flow through the body tissue around the heart. Three or five leads, placed on the skin on opposite sides of the heart, transmit the electrical potentials to circuitry in the monitor.

The monitor's ECG circuitry amplifies, filters, and digitizes (converts analog signals to digital signals) the received electrical potentials. The digitized signals are used to display the ECG waveform and calculate the ECG heart rate.

### ECG Warnings, Cautions, & Notes

**WARNING! PACEMAKER PATIENTS.** Rate meters may continue to count the pacemaker rate during occurrences of cardiac arrest or some arrhythmias. Do not rely entirely upon rate meter alarms. Keep pacemaker patients under close surveillance. See this manual for disclosure of the pacemaker pulse rejection capability of this instrument.

**WARNING! PACEMAKER PATIENTS.** If PACE DETECT is not turned on when monitoring pacemaker patients the heart rate readouts derived from the ECG patient connections are likely to display erroneous high or erratic rates. Keep pacemaker patients under close surveillance. For pacemaker patients it may be advisable to select the SpO<sub>2</sub> parameter as the primary heart rate source.

**WARNING!** Connect only three-lead or five-lead ECG lead wires from the patient to the ECG patient cable. Do not connect any other signal source to the ECG patient cable.

**WARNING!** False low heart rate indicators or false Asystole calls may result with certain pacemakers because of electrical overshoots.

**WARNING!** Reliable monitoring of pacemaker patients can only occur with the pace detect on.

**WARNING!** The pacemaker spike shape and size is not to be diagnostically interpreted.

**WARNING!** Monitoring of pacemaker patients can only occur with the PACE DETECT on.

**WARNING!** Keep pacemaker patients under close observation. Rate detection in the software may continue to count the pacemaker rate during cardiac arrest and/or arrhythmia conditions. Therefore, do not rely solely on rate detection alarms.

**WARNING!** Do not use line isolations transformers with this monitor. Line isolation monitor transients may resemble actual cardiac waveforms and thus inhibit heart rate alarms.

**WARNING!** Electrodes of dissimilar metals should not be used.

**NOTE:** Follow institutional standards when applying ECG electrodes. Silver/Silver Chloride disposable electrodes are strongly recommended to avoid polarization effects that result in large input offset potentials. Use of "squeeze bulb" type electrodes is not recommended.

**NOTE:** Use only standard AAMI three-lead or five lead ECG cables.

## Using the ECG Parameter

If not familiar with this monitor and the ECG parameter, follow this chapter's sections in order:

### Setting Up ECG Monitoring

Ensure the ECG parameter is turned on. Refer to the **ECG** Menu for enabling the monitor.

### Attaching the Patient

Attach the ECG leads and connect the ECG patient cable to the monitor.

### ECG Display

Shows a typical screen and explains the ECG display's features.

### ECG Menu



Choose the ECG limb lead selection, size, pace detect, and number of leads

### ECG Messages

Defines the ECG alarms, alerts, and messages.








## Setting Up ECG Monitoring

Follow the steps in *Chapter 3: Setting Up the Monitor*. The remainder of this chapter assumes the monitor is installed and turned on.

The ECG parameter can be turned on or off in the ECG menu. To ensure the ECG parameter is on, press the  key. Use the ARROW (   ) keys to highlight the **ECG** option. Press the  key again to enter the ECG menu. Use the ARROW (   ) keys to highlight the **ECG Monitor** option, and confirm the option is set to **YES**.

## Calibration Waveform

The calibration waveform can be activated to check the accuracy of the printer and/or analog output waveform as well as the display. The calibration waveform is activated as follows:

1. When the monitor is turned on, simultaneously press the Wave/Trend  and Menu/Enter  keys to enter the **Service Mode**.
2. Use the ARROW (   ) keys to highlight the **Calibration** option.
3. Use the ARROW (   ) keys to toggle between **ON** and **OFF**, then select desired option by pressing the Menu/Enter  key.

## Attaching the ECG Leads to the Patient

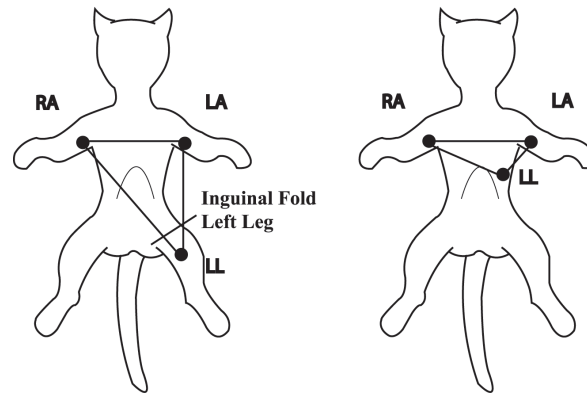


Figure 5.1: Attach the Electrodes to the Patient

Make sure that the alligator clips and banana plugs on the ECG leads are thoroughly cleaned and dry before attaching to the patient. If the alligator clip and the banana plugs are dirty, ECG signal quality may be compromised.

To attach the ECG leads to the patient, position three alligator clips in the standard configuration. White for right arm, black for left arm, and red for left leg (see figure 5.1), or position leads on chest to decrease motion artifact, or to monitor large animals (see figure 5.1).

If necessary, moisten the sites lightly with isopropyl alcohol. **Do not use betadine.**

## Attaching the Patient

**NOTE:** Follow institutional standards when applying ECG electrodes.

**NOTE:** The ECG cable uses a standard AAMI three-lead or five-lead ECG connector. Use only standard AAMI three-lead or five-lead ECG wires.

**NOTE:** The ECG patient circuit is electrically isolated.

**NOTE:** The monitor is protected against damage from defibrillator, diathermy, and electrocautery discharge.

**NOTE:** To remove the ECG cable, grip the connector and pull back firmly. **DO NOT** pull on the ECG cable to remove the ECG connector from the monitor.

Connect the ECG cable to the monitor. Align the key on the monitor's ECG receptacle with the notch in the ECG connector. Push the connector firmly into the receptacle.

**WARNING!** Electrodes of dissimilar metals should not be used.

**CAUTION!** Ensure conductive parts, including electrodes, of the patient cable do not come in contact with any conductive surfaces or earth parts.

Connect the ECG leads, then connect the leads to the ECG cable. Ensure the leads are in the correct ECG cable position. The ECG leads and patient cable connector are color-coded according to the AAMI standard for ECG leads.

Table 5.1: ECG 3-Lead Electrode Identification

ELECTRODE LABEL	LOCATION	COLOR
RA	Right Arm	White
LA	Left Arm	Black
LL	Left Leg	Red

Table 5.2: ECG 5-Lead Electrode Identification

ELECTRODE LABEL	LOCATION	COLOR
RA	Right Arm	White
RL	Right Leg	Green
LA	Left Arm	Black
LL	Left Leg	Red
V	4th Intercostal Space (right)	Brown

ECG Display

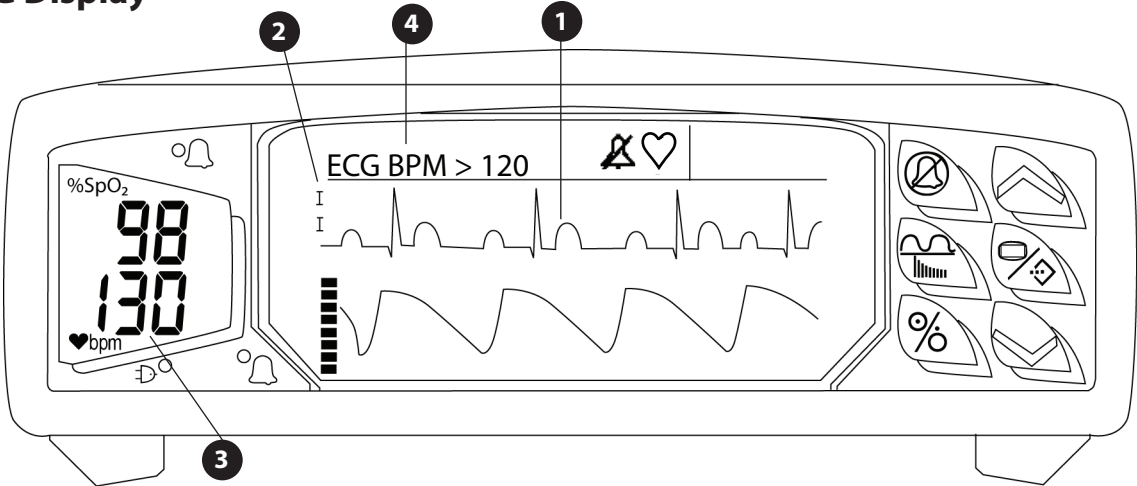



Figure 5.2: ECG Display

A few seconds after the patient is attached, the ECG waveform measurements should be shown.

**NOTE:** If measurements are not shown, check the patient attachment and leads to make sure they are applied correctly. If necessary, check for ECG messages and see ECG Messages later in this chapter for help.

**1 ECG Waveform**

The ECG waveform is shown, assuming it is assigned to a trace. Press the  key to assign the ECG waveform to a trace. The wave's height, speed, and lead number are remembered at power down.

**2 Lead**

The lead selection is identified by the lead label. The following lead selections are available: I, II, III, aVR, aVL, aVF, and V.

**3 Heart Rate (♥bpm)**

The heart rate is shown if ECG is selected as the bpm source in the **SETUP/VOLUME** menu.

**4 Messages**

ECG alarm and alert messages appear on the first line of the message area at the upper left of the display. If more than one message is to be displayed, the messages will alternate at a rate of about one per second. For details on the ECG messages, see ECG Messages later in this chapter.

## ECG Menu

The **ECG** menu allows the user to view and/or adjust ECG monitoring settings.

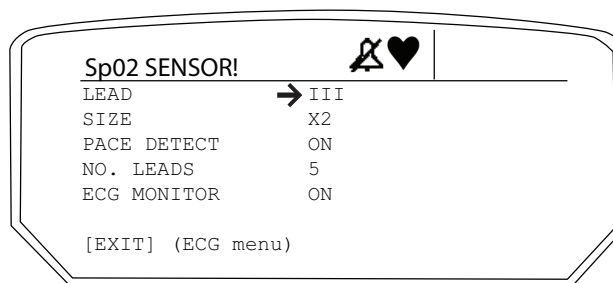


Figure 5.3: ECG Menu

### LEAD

This menu item allows you to choose the waveform primary lead. If using a three-lead cable the following lead selections will appear; I, II, or III allowing one waveform to be displayed. These leads are acquired and analyzed.

If using a five-lead cable the following lead selections will appear; I, II, III, and V are simultaneously acquired and analyzed, the augmented leads AVR, AVF, and AVL are calculated.

### SIZE

This menu item allows you increase the size of the ECG tracing in the following increments: 1X, 2X, 4X and 8X. The default size is 1X.

SIZE	SCALE
1X	$\pm .5$ mV
2X	$\pm 2.5$ mV
4X	$\pm 1.25$ mV
8X	$\pm 0.625$ mV

### PACE DETECT

This option turns ON/OFF the pacemaker detection/rejection program in the monitor. This menu option should be used when the patient being monitored has a pacemaker. All pacemaker pulses as specified by AAMI are detected or rejected in the ECG waveform when PACE DETECT is turned ON. An artificial pulse is added to all displayed ECG waveforms marking the pacemaker discharge. The monitor defaults OFF so if you have a patient with a pacemaker, you will have to turn ON the PACE DETECT option.

**WARNING! False low heart rate indicators or false Asystole calls may result with certain pacemakers because of electrical overshoots.**

**WARNING! Monitoring of pacemaker patients can only occur with the PACE DETECT on.**

**WARNING! The pacemaker spike shape and size is not to be diagnostically interpreted.**

**WARNING! Keep pacemaker patients under close observation. Rate detection in the software may continue to count the pacemaker rate during cardiac arrest and/or arrhythmia conditions. Therefore, do not rely solely on rate detection alarms.**

### NO. LEADS

Indicates the number of ECG leads: either 3 or 5. Choose the number of leads to match the type of ECG cable being used.

### THRESHOLD

This menu option allows the user to select the ECG QRS detection threshold.

## ECG MONITOR

Indicates whether the ECG monitor is on or off. Allows the ECG parameter to be turned on or off.

**NOTE: Turning off the ECG parameter turns off the ECG waveform and heart rate measurements. Heart rate measurements (if  bpm SOURCE = ECG) will be replaced by pulse rate measurements.**

## ECG Messages

Alarm messages related to ECG are shown on the top message line at the upper left of the display. If there are several messages to be displayed, then they rotate, showing one message every second.

If ECG monitoring is disabled through menus, then the message “**ECG MONITOR OFF**” is displayed in the ECG waveform area.

### Alarm Messages

#### ECG BPM > (x)

Indicates the ECG measurement is equal to or higher than the high ECG alarm limit. (x) is the high alarm limit setting.

#### ECG BPM < (x)

Indicates the ECG measurement is equal to or lower than the low ECG alarm limit. (x) is the low alarm limit setting.

#### ASYSTOLE

This high priority alarm is generated and the text is displayed in the parameter box when all ECG lead are connected to the patient, ECG processing is turned on, and no ECG QRS signal is detected within a 6 second period.

#### ECG/LEAD FAIL

This message is displayed when any lead fails on a three-lead ECG connection or when the RL lead fails or when any two of the LA, RA, or LL leads fail on a five-lead ECG connection. This is a low priority alarm.

### Status Message

#### ECG MONITOR OFF

Indicates the ECG function has been disabled through menus. This message replaces the ECG waveform.

## Chapter 6: Oximetry

### General Description

The SurgiVet® V3404 Oximeter noninvasively and continuously monitors and displays arterial blood oxygen saturation ( $\text{SpO}_2$ ), pulse rate, and plethysmogram. The V3404 beeps with each pulse beat. The pitch of the pulse beep depends on the  $\text{SpO}_2$  value; the higher (or lower) the  $\text{SpO}_2$  value, the higher (or lower) the pulse beep pitch.

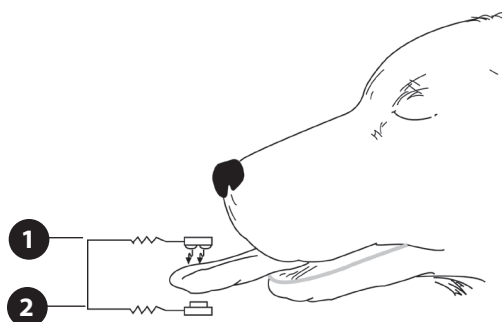
The V3404 flexible alarm system lets you choose alarm parameters and audible tone volumes. You can select the high and low alarm limits for  $\text{SpO}_2$  and pulse rate, and independently choose the volume for alarm and pulse beep tones.

### Pulse Oximetry Theory of Operation

The pulse oximeter determines  $\%\text{SpO}_2$  and pulse rate by passing two wavelengths of low intensity light, one red and one infrared, through body tissue to a photodetector. Information about wavelength range can be especially useful to clinicians. Wavelength information for this device can be found in the  $\text{SpO}_2$  Specifications section of this manual.

Pulse identification is accomplished by using plethysmographic techniques, and oxygen saturation measurements are determined using spectrophotometric oximetry principles. During measurement, the signal strength resulting from each light source depends on the color and thickness of the body tissue, the sensor placement, the intensity of the light sources, and the absorption of the arterial and venous blood (including the time varying effects of the pulse) in the body tissues.

Figure 6.1: Pulse Oximetry Theory of Operation



**1 Low intensity Red and Infrared LED light sources**

**2 Detector**

Oximetry processes these signals, separating the time invariant parameters (tissue thickness, skin color, light intensity, and venous blood) from the time variant parameters (arterial volume and  $\text{SpO}_2$ ) to identify the pulses and calculate functional oxygen saturation. Oxygen saturation calculations can be performed because blood saturated with oxygen predictably absorbs less red light than oxygen-depleted blood.

**WARNING! Since measurement of  $\text{SpO}_2$  depends on a pulsating vascular bed, any condition that restricts blood flow, such as the use of a blood pressure cuff or extremes in systemic vascular resistance, may cause an inability to determine accurate  $\text{SpO}_2$  and pulse rate readings.**

**WARNING! Under certain clinical conditions, pulse oximeters may display dashes if unable to display  $\text{SpO}_2$  and/or pulse rate values. Under these conditions, pulse oximeters may also display erroneous values. These conditions include, but are not limited to: patient motion, low perfusion, cardiac arrhythmias, high or low pulse rates or a combination of the above conditions. Failure of the clinician to recognize the effects of these conditions on pulse oximeter readings may result in patient injury.**

## Patented Technology

The monitor's oximetry incorporates patented technology and noise reducing hardware to enhance the oximeter's ability to detect pulse amplitude in patients with poor peripheral perfusion. Blood Pulse Detection Method Using Autocorrelation, patent number 5,558,096, analyzes a digitized signal, in real time, and compares it with previous pulse data. If similar characteristics to previous data are recognized, the device confirms a valid pulse. In essence, an individual's pulse data is retained and used as a template to accept or reject future pulse signals. Patented technology, digital signal processing, and a greatly improved signal to noise ratio, provide for improved performance.

## Oximeter Display

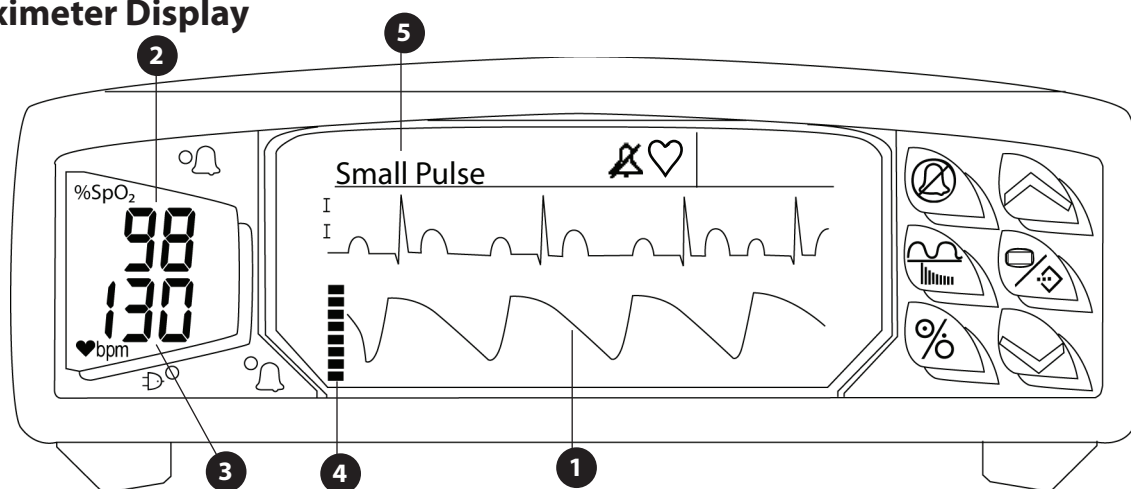


Figure 6.2: Oximeter Display

A few seconds after the patient is attached, the SpO<sub>2</sub> measurement, pulse rate measurement, and pulse bargraph should be shown.

**NOTE:** If measurements are not shown, check the patient attachment to make sure it is applied correctly. Also check for oximeter messages in the alarm and alert message area and see *Oximeter Messages* later in this chapter for help.

### 1 Plethysmogram (SpO<sub>2</sub> waveform)

The plethysmogram is shown, assuming it is assigned to a trace. Press the  $\alpha$  key to assign the plethysmogram to a trace.

### 2 SpO<sub>2</sub> Measurement

The SpO<sub>2</sub> measurement is shown. Dashes (---) indicate the measurement is invalid or unavailable.

### 3 Pulse Rate Measurement

The pulse rate measurement is shown. Dashes (---) indicate the measurement is invalid or unavailable.

### 4 Pulse Strength Bargraph

Indicates the patient's pulse activity and strength. The bargraph is logarithmically scaled to indicate a wide range of pulse strengths.

### 5 Messages

Oximeter alarm and alert messages appear on the second line of the message area at the upper left of the display. If there are several messages to be displayed, then they alternate, showing one message every second. For details on the oximeter messages, see *Oximeter Messages* later in this chapter.



## Oximeter Menu

The oximeter menu allows the user to view and/or adjust oximeter monitoring settings.

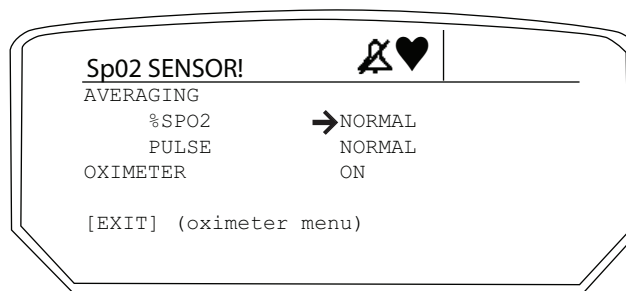


Figure 6.3: Oximeter Menu

### Averaging





Indicates the current SpO<sub>2</sub> and pulse rate averaging setting. Allows the averaging setting to be changed. See *Adjusting or Viewing the Averaging Settings* later in this chapter for more information on averaging settings.

### Oximeter

Indicates whether the oximeter parameter is enabled or disabled. Allows the oximeter parameter to be turned on or off.

**NOTE: Turning off the SpO<sub>2</sub> parameter turns off the plethysmogram, SpO<sub>2</sub>, pulse rate, and pulse strength measurements.**

## Adjusting the Pulse Beep Volume

1. Select **SET/VOLUME** from the Main menu.
2. Under **VOLUME** select the **PULSE** item.
3. Press the  key to select the item. Use the ARROW keys (   ) to adjust the pulse volume. A visual graph displays the pulse volume level. Press  to set the value

**NOTE: The pulse beep sounds while adjusting the volume.**






4. Select **[EXIT]** or press  to exit the menu.

**NOTE: The pitch of the pulse beep is determined by the SpO<sub>2</sub> value. The higher the SpO<sub>2</sub> value, the higher the pulse beep pitch. The lower the SpO<sub>2</sub> value, the lower the pulse beep pitch.**

## Adjusting or Viewing the Averaging Settings

SpO<sub>2</sub> averaging is the number of pulse beats over which the SpO<sub>2</sub> value is averaged. Rate averaging is the number of seconds over which the pulse rate is averaged. Three averaging settings are available: Normal, Fast, and Slow (4, 8, 16 beats).

To adjust or view the averaging settings, do the following:

1. Select the **OXIMETER** item from the Main menu.
2. Select the **AVERAGING** item.
3. Press the  key to select the item. Use the ARROW (   ) keys to adjust the averaging. Press the  key to set the value.
4. Select **[EXIT]** or press  to exit the menu.

**NOTE:** Increasing or decreasing the averaging setting has no effect on the data update rate.

## Oximeter Messages

Oximeter messages are shown on the second line of the message area at the upper left of the display. If there are several messages to be displayed, then they alternate, showing one message every second.

### High Priority Alarm Messages


#### **SpO<sub>2</sub> > (x)**

Indicates the SpO<sub>2</sub> measurement is equal to or higher than the high SpO<sub>2</sub> alarm limit. (x) is the high alarm limit setting.


#### **SpO<sub>2</sub> < (x)**

Indicates the SpO<sub>2</sub> measurement is equal to or lower than the low SpO<sub>2</sub> alarm limit. (x) is the low alarm limit setting.

#### **Pulse > (x)**

Indicates the pulse rate measurement is equal to or higher than the high PULSE alarm limit. (x) is the high alarm limit setting. (Only if  bpm SOURCE = OXIMETER.)

#### **Pulse < (x)**

Indicates the pulse rate measurement is equal to or lower than the low PULSE alarm limit. (x) is the low alarm limit setting. (Only if  bpm SOURCE = OXIMETER.)

#### **Lost Pulse**

Indicates that the oximeter no longer detects a pulse while the sensor is on the patient, where a pulse was previously detected.

## Low Priority Alarm Messages

### SpO<sub>2</sub> SENSOR!

Indicates the SpO<sub>2</sub> sensor is disconnected from the monitor or the patient. Make sure the patient cable and sensor connectors are all firmly seated. Make sure the sensor is positioned properly on the patient. If the message persists, contact your authorized repair center.

### SpO<sub>2</sub> Signal

Indicates the oximeter circuitry could not measure the patient's SpO<sub>2</sub> or pulse rate. Make sure the sensor is positioned properly on the patient.

### SpO<sub>2</sub> Artifact

Indicates the presence of excessive artifacts. Check sensor positioning on the patient and restrict patient movement.

## Messages

### SpO<sub>2</sub> Search

Indicates the oximeter is adjusting to the patient's signal. If this message persists, check for proper sensor positioning on the patient.

**NOTE:** If the message "SpO<sub>2</sub> SEARCH" stays up for 10 seconds or more, a system alert will sound.

### Small Pulse

Indicates the oximeter signal strength is low. Try repositioning the sensor on the patient, or warming the extremity to encourage blood flow.

## Attaching the Patient - Oximetry

### Choose the Sensor

PATIENT	SITE	CATALOG NO. & DESCRIPTION
Small/Medium Animal up to 60 pounds	Pinna (ears), Toe Webbing, Tongue	V1711: Large 'Y' Sensor V1702: Mini 'Y' Sensor V3078: Mini Clip Sensor
	Rectum/Tail	V1700: Reflectance Sensor V1710: Tail Wrap Sensor
	Hock, Achilles Tendon, etc.	V1707: Universal 'C' Sensor
Large Animals over 60 pounds	Pinna (ears), Toe Webbing, Tongue	V1711: Large 'Y' Sensor V1702: Mini 'Y' Sensor V3078: Mini Clip Sensor
	Rectum/Tail	V1700: Reflectance Sensor V1710: Tail Wrap Sensor
	Hock, Achilles Tendon, etc.	V1707: Universal 'C' Sensor
Equine	Tongue	V1707L Universal 'C' Sensor

## Clean or Disinfect the Reusable Sensor

If you choose a reusable sensor, clean or disinfect the sensor before attaching a new patient.

**WARNING! Do not autoclave, ethylene oxide sterilize, or immerse the sensors in liquid.**

**CAUTION! Unplug the sensor from the monitor before cleaning or disinfecting.**

Clean the sensor with a soft cloth moistened in water or a mild soap solution. To disinfect the sensor, wipe the sensor with isopropyl alcohol.

## Check Sensor Integrity

Before the sensor is attached to the patient, check the integrity of the sensor, oximetry cable, and oximeter as follows:

1. Make sure the red light in the sensor is illuminated.
2. Make sure the **SpO2 SENSOR!** message is displayed on the EL Display.

**NOTE: Obstructions or dirt on the sensor's red light or detector may cause the checks to fail. Make sure there are no obstructions and the sensor is clean.**

3. Connect the sensor as follows:
  - a. For "Y" sensors, wrap sensors, and disposable sensors: Align the sensor's red light with the detector so they are less than 1/8 inch away from each other. Make sure the **SpO2 SENSOR!** message is displayed on the message area of the EL Display.

## Attach the Sensor to the Patient

**WARNING! Prolonged use or the patient's condition may require changing the sensor site periodically. Change sensor site and check skin integrity, circulatory status, and correct alignment at least every 4 hours.**

**WARNING! When attaching sensors with Microfoam<sup>®</sup> tape, do not stretch the tape or attach the tape too tightly. Tape applied too tightly may cause inaccurate readings and blisters on the patient's skin (lack of skin respiration, not heat, causes the blisters).**

**WARNING! Failure to place the monitor away from the patient may allow the patient to turn off, reset, or damage the monitor, possibly resulting in the patient not being monitored. Make sure the patient cannot reach the monitor from their bed or enclosure.**

**WARNING! Failure to carefully route the cable from the sensor to the monitor may allow the patient to become entangled in the cable, possibly resulting in patient strangulation. Route the cable in a way that will prevent the patient from becoming entangled in the cable. If necessary, use tape to secure the cable.**

## Pulse Oximeter Sensors

**NOTE!** ⚠ Please see insert accompanying each sensor for further details.

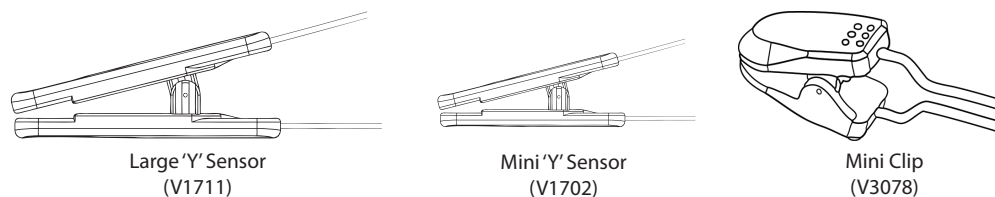


Figure 4.2: Lingual Sensors

Attach the sensor and clip to the patient's tongue. Make sure the light source is topside of the tongue.



Figure 4.3: Attaching the Sensor to the Animal

## Reflectance Sensors

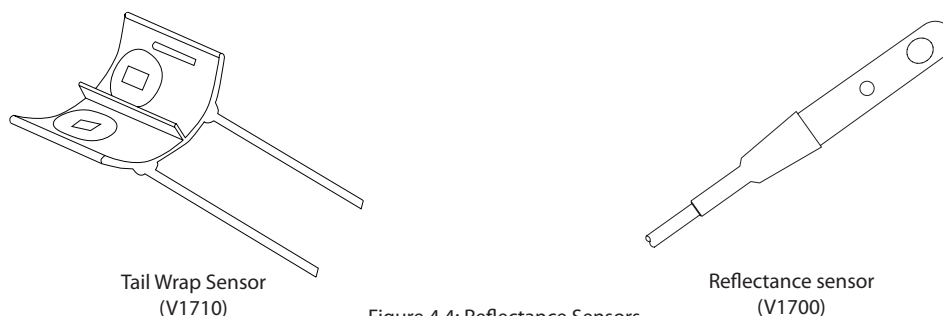


Figure 4.4: Reflectance Sensors

For best results while using the tail wrap sensor (V1710), apply to the ventral base of the tail with the divider positioned centrally. Moisten the fur and parting at the application site or shaving a small area is required. The sensor works best on medium to large sized patients.

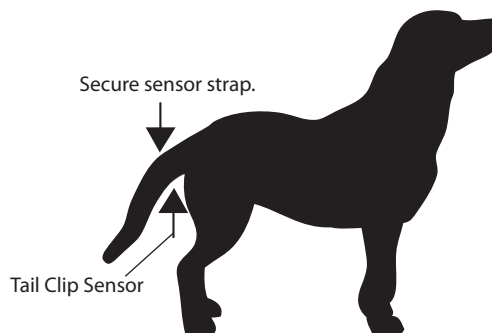


Figure 4.5: Attaching the Sensor to the Animal

For best results while using the reflectance sensor (V1700), apply to the base of the tail. This sensor can also be used rectally if needed.

When using either of the reflectance sensors, ultrasound gel is recommended to enhance performance. Fur, dark pigmentation, poor perfusion and movement can affect the sensor's ability to obtain accurate readings.

## Pulse Oximeter Sensor Application Tips

There is some variation depending on the manufacturer, but there are three basic types of pulse oximeter sensors made for the small animal patient:

- Large and Mini 'Y' sensors
- Mini Clip sensor
- 'C' sensor (may also be used on large animals)
- Tail Wrap sensor
- Reflectance sensor

It is very important to have a variety of sensors in order to monitor the majority of the small animal patients. It is also important to select the proper sensor for animals based on their size, color, fur type, medical condition, and type of procedure.

## Testing Sensor Function

- 1. To test the large and mini 'Y' sensor functions**, turn on the monitor with the lingual sensor attached. View the sensor to make sure a red light is being emitted, then place the sensor on a small finger (without nail polish). Rest the hand with the sensor on it on a table to minimize motion. Note that in most cases the red light should be shining in the same direction as the overhead or surgical lights. It is important that the light receptor is shielded in order to avoid interference from ambient light. Once placed on a patient site, the red light should be shining continuously. In some cases a blinking light indicates that the tissue thickness is either too thin or thick. Once the sensor is placed properly, both the SpO<sub>2</sub> and pulse rate should appear in a short period of time (10-15 seconds).
- 2. Testing the 'C' sensor is performed in the same manner.** This is a stronger sensor and can be used with greater tissue thickness.
- 3. Testing the tail wrap and reflectance sensors are performed in the same manner**, but it should be pressed between thumb and index finger or into the palm of your hand.

## Primary Applications for Sensors

### Large and Mini 'Y' Sensor and Mini Clip Sensor

- The primary application site is the tongue for most animals. On cats and small dogs, fold the tongue like a taco or use a wet gauze pad of single thickness folded over the tongue, and then place the sensor over the gauze.
- Other sites include the prepuce or vulva of larger dogs, the achilles tendon of a cat or small dog, ears, or toe webbing.

### C Sensor

- For cats and small breed dogs, place the sensor on the thigh, metatarsal or metacarpal, or hock near the saphenous vein.
- For larger breed dogs, place the sensor over the Achilles tendon, tongue, prepuce or vulva, or through toe webbing.
- It may be necessary to wet and part the fur with water in order to get the sensor closer to the skin of the patient.
- For large animals (e.g. horses), place the sensor on the tongue.

## Tail Wrap Sensor and Reflectance Sensor

- In most animals, wet and part the fur at the ventral tail base and use the straps on the tail wrap to hold the tail wrap sensor in place.
- When using the reflectance sensor, wet and part the fur at the ventral tail base and use non-adhesive tape to hold the sensor in place. The reflectance sensor may be used rectally if the patient has a small or no tail.
- It may be necessary to shave a small spot on the ventral tail base in patients with a thick undercoat, such as a Husky.

## Limitations

Experience will quickly tell you which probes work best under different conditions. Fur, dark pigmentation, poor perfusion, and movement can all affect the sensors ability to obtain accurate readings. Well-perfused sites with little or no hair are preferable. It is also important to note that some anesthetic drugs, such as Xylazine (Rompun), Acepromazine, or Medetomidine (Domitor) can affect peripheral pulse pressures causing very weak pulsations. All pulse oximeters require a good quality pulse to work properly. Other drugs, such as ketamine, can cause the tongue to twitch, limiting the use of a lingual clip on that site.

## Checking the Oximeter's Performance

Pulse oximeters do not require user calibration. If checking the function of the device is desired, an optional Oximetry/ECG Patient Simulator (SMPM catalog number 1606) is available as an accessory. The simulator attaches to the oximeter in place of the sensor or oximetry cable. It provides a known SpO<sub>2</sub> and pulse rate signal to the oximeter. This allows the oximeter's performance to be checked.

**NOTE! The 1606 Oximetry/ECG Patient Simulator does not calibrate the monitor; the monitor does not require calibration. The 1606 provides a known SpO<sub>2</sub> and pulse rate to the monitor that allows you to check the monitor's performance.**


**NOTE! The 1606 Oximetry/ECG Patient Simulator cannot be used to assess the accuracy of a pulse oximeter and/or sensor.**

**NOTE:**  Follow the instructions included with the 1606 Oximetry/ECG Patient Simulator.

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## Chapter 7: Trends

Press the  key to cycle through displays until Trends are shown. Trends can be displayed for SpO<sub>2</sub>, Pulse Rate, or Signal Pulse Strength. The following diagram and descriptions outline the trend display's features.

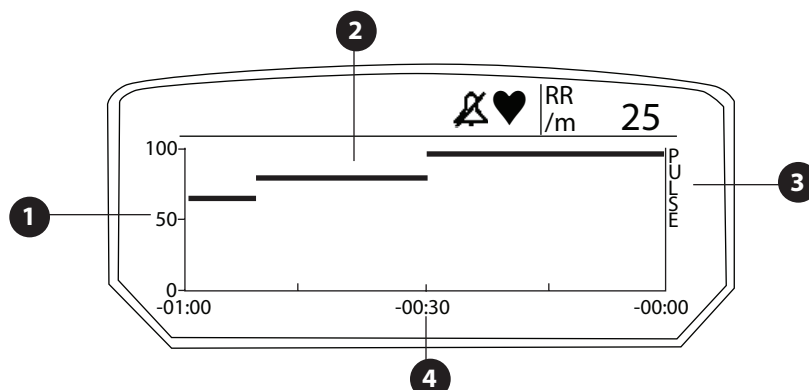


Figure 7.1: Trend Display

### 1 Scale

The trend's scale is shown on the left side of the trend display.

### 2 Trend Graph





The trend graph is displayed here. Displayed trends show elapsed time, that is, what happened over the selected minutes or hours. Gaps will appear in the trend graph for the length of time the monitor has been off or the parameter data has been invalid.

### 3 Trended Parameter

The name of the trended parameter is displayed here. Trended parameters are the following: signal, respiration, % SpO<sub>2</sub>, pulse, and temperature.

### 4 Trend Time

The time scale of the trend is displayed here. Trend data and time are continuously updated.

When  is pressed, the previously viewed trend can be displayed. To view a different trend, press an ARROW (   ) key until the desired trend is displayed. Press  to view one or two waveforms again. Trend times and scales are selected with the **TRENDS** menu item (see *Trends Menu*).

# Trends Menu

The Trends menu allows the user to view and/or adjust the trend settings.

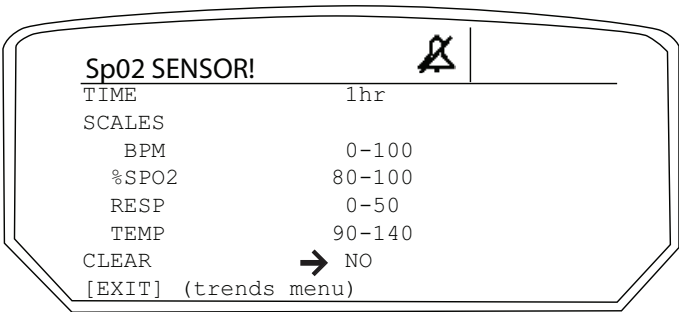


Figure 7.2: Trends Menu

## TIME

Adjusts the time span of the trend display.

## SCALES

Allows a separate trend scale to be selected for each parameter. The scale for oximeter signal strength is not selectable.

## CLEAR

Select **Yes** to erase trend memory.

Trend data will not be lost if this selection is set back to **No** before **[EXIT]** is selected, or the menu times out.

**NOTE: “Yes” means all trended data will be erased when the trend menu is exited or allowed to time out.**

**NOTE: If trends are not cleared, trend data is remembered at power down.**

## Chapter 8: Serial Output

### Serial Out Menu

The **SERIAL OUT** menu allows the user to select a data format for output to the serial port, as well as select the output interval or the amount of data to send. This data can be output to a computer or to a compatible printer.

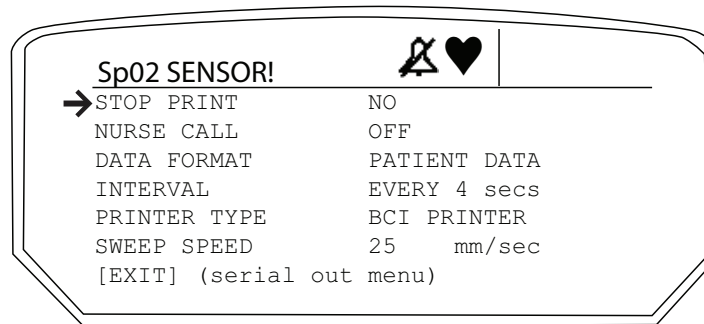


Figure 8.1: Serial Out Menu, Patient Data

#### STOP PRINT

Select this to enable/disable serial output.

#### NURSE CALL

Select this to enable/disable the nurse call serial output.

#### DATA FORMAT

Shows data output type: Patient Data or Trend Tables. [See *Serial Output Setup* later.]

#### INTERVAL

If **PATIENT DATA** format has been selected, this shows the amount of time between data log outputs.

#### PRINTER TYPE

Select either **RS-232** (text only) or **BCI PRINTER** (graphics).

#### SWEEP SPEED

If the BCI® printer has been selected, this shows the paper speed.

**WARNING!** When connecting this monitor to any instrument, verify proper operation before clinical use. Refer to the instrument's user manual for full instructions. Accessory equipment connected to the monitor's data interface must be certified according to the respective IEC standards, i.e., IEC 950 for data-processing equipment or IEC 601-1 for electromedical equipment. All combinations of equipment must be in compliance with IEC 601-1-1 systems requirements. Anyone connecting additional equipment to the signal input port or signal output port configures a medical system, and, therefore, is responsible that the system complies with the requirements of the system standard IEC 601-1-1.

**WARNING! IEC 950 approved equipment must be placed outside of the “patient environment.” The patient environment is defined as an area 1.5m (4.92 feet) from the patient.**

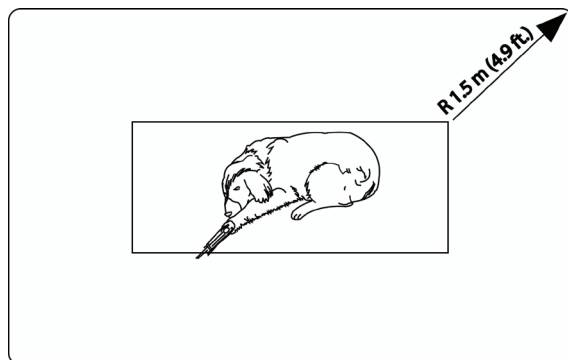


Figure 8.2: Patient Environment

## Serial Output Setup for RS-232 Connections

The serial output data format and output interval or amount can be changed only if no serial output is in progress. To change the data format selection:

1. Select **SERIAL OUT** from the Main Menu. If **START PRINT = NO**, then no serial output is currently in progress, so proceed with step 2. Otherwise, **START PRINT = YES** and you must select **NO** to halt the current output before the serial output data settings can be changed.

To change the data format (Patient Data or Trend Tables):

2. Use the ARROW keys (  $\wedge$   $\vee$  ) to point to the **DATA FORMAT** item, then press  $\text{F4}$ .
3. Use the ARROW keys (  $\wedge$   $\vee$  ) to switch between formats. When the format changes, the menu item below it changes.
4. Press  $\text{F4}$  to accept the selection.

If **PATIENT DATA** is selected, the menu item displayed below it is: **INTERVAL**. (See Figure 10.1)

To change the output **INTERVAL**:

1. Use the ARROW keys (  $\wedge$   $\vee$  ) to point to **INTERVAL**, then press  $\text{F4}$ .
2. Use the ARROW keys (  $\wedge$   $\vee$  ) to change the value.
3. Press  $\text{F4}$  to accept the selection.

If **TREND TABLES** is selected, the menu item below it is: **PRINTER TYPE**.

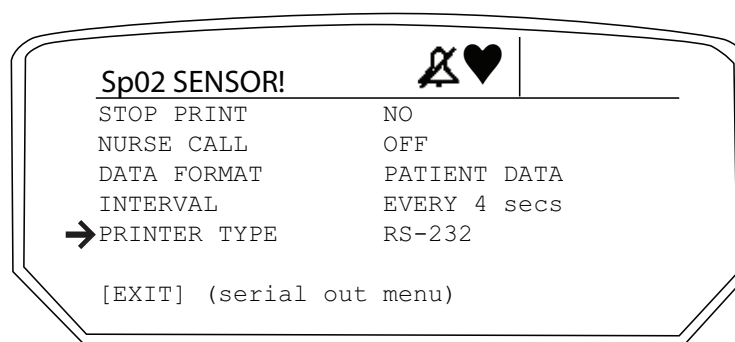


Figure 9.3: Serial Out Menu, Trend Tables

To change the **PRINTER TYPE**:

1. Use the ARROW keys ( ^ v ) to point to **PRINTER TYPE**, then press .
2. Use the ARROW keys ( ^ v ) to change the value to **RS-232**.
3. Press to accept the selection.
4. When the output format has been chosen, set **START PRINT** to **YES** to enable the serial output.
5. Select **[EXIT]** or press to exit menus. If serial output is in progress, exiting menus will not stop it.

To STOP serial output:

1. Select **SERIAL OUT** from the main menu.
2. Set **START PRINT** to **NO**.

**NOTE:** Serial output is always disabled when the monitor is powered off, then on, but the format and times are remembered.



**NOTE:** If printing trend tables, **START PRINT** changes to **STOP PRINT** until all trend data is printed. When all data is printed /sent, **STOP PRINT** changes to **START PRINT**.

## Serial Output Setup for Graphics Printer

The optional BCI® printer enables the user to print real-time strip charts of the patient's activity. To setup printing do the following:

1. Select **SERIAL OUT** from the Main Menu. If **STOP PRINT = NO**, then no serial output is currently in progress, so proceed with step 2. Otherwise, **STOP PRINT = YES** and you must select **NO** to halt the current output before the serial output data settings can be changed.

To change the data format (Patient Data or Trend Tables):

2. Use the ARROW keys ( ^ v ) to point to the **DATA FORMAT** item, then press .
3. Use the ARROW keys ( ^ v ) to switch between formats. When the format changes, the menu item below it changes.
4. Press  to accept the selection.
5. If **PATIENT DATA** is selected, the menu item displayed below it is: **INTERVAL**.

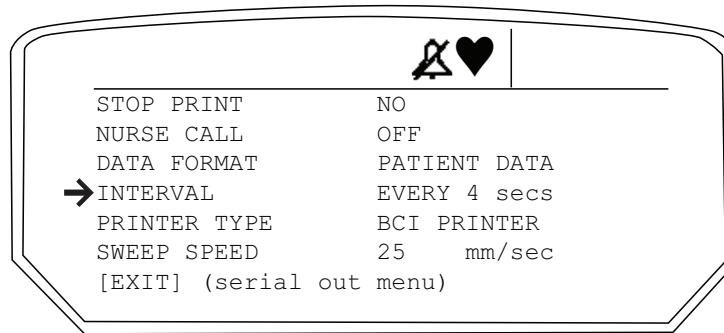




Figure 8.4: Serial Out Menu, Patient Data (BCI® Printer)

To change the output **INTERVAL**:

1. Use the ARROW keys ( ^ v ) to point to **INTERVAL**, then press .
2. Use the ARROW keys ( ^ v ) to change the value.
3. Press  to accept the selection.

If **TREND TABLES** is selected, the menu item below it is: **PRINTER TYPE**.

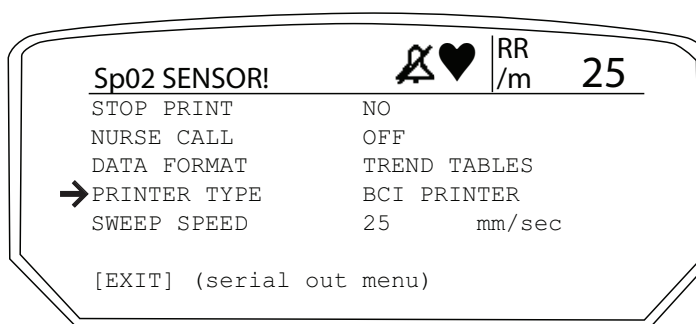







Figure 8.5: Serial Out Menu, Trend Tables (BCI® Printer)

To change the **PRINTER TYPE**:

1. Use the ARROW keys ( ^ v ) to point to **PRINTER TYPE**, then press .
2. Use the ARROW ( ^ v ) keys to change the value to **BCI PRINTER**.
3. Press  to accept the selection.
4. Use the ARROW keys ( ^ v ) to point to **SWEEP SPEED**, then press .
5. Use the ARROW keys ( ^ v ) to select the desired print speed, then press .
6. When the output format has been chosen, press waveform key on BCI® printer to start waveform printing, or SpO<sub>2</sub> key for text printing.
7. Select **[EXIT]** or press  to exit menus. If serial output is in progress, exiting menus will not stop it.

To STOP serial output:

1. Select **SERIAL OUT** from the main menu.
2. Set **STOP PRINT** to **NO**.

**NOTE:** Serial output is always disabled when the monitor is powered up, but the format and times are remembered.

# Output Examples

## Patient Data

### RS-232 Source

A real-time Patient Data sample is output in tabular ASCII text format, one table per output interval when connected to an RS232 source. The time interval between tables is selected in the SERIAL OUT menu. Each line of text in the patient data table ends with a carriage return, line feed.

```
PATIENT DATA
Patient_____
Date_____
BPM      SpO2      RR/m      Temp
```

Sample Output: (RS-232 Source)

### Optional BCI® Printer

A real-time Patient Trace is recorded.

Sample Output: (BCI® Printer)

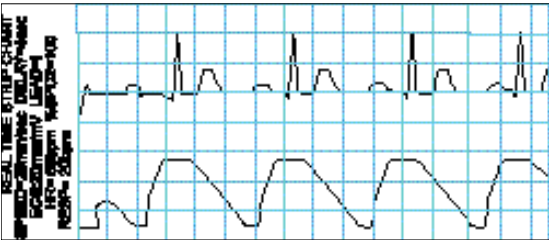


Figure 8.7: Real-Time ECG/Pleth Traces

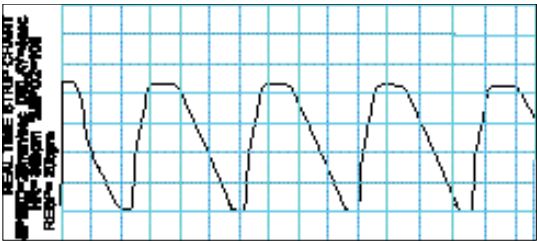


Figure 8.8: Real-Time Pleth Waveform



Figure 8.9: Real-Time ECG Trace



## Trend Table Data

Trend data is output in tabular ASCII text format, one table per trend data record, starting at the oldest record. Trend data is stored every 30 seconds. This interval is not user adjustable. A maximum of 21 hours of trend data storage is possible. Every time the monitor is turned off, then on again, a new block of trend data is started in trend memory. Thus, data from days ago might be printed, because trend data is remembered when the monitor is turned off. For this reason, time stamps are stored and output along with trended parameter data.

Each line of text in the trend tables ends with a carriage return, line feed.

Each new block of many trend data records has the following title information:

```
Trend Table
Patient_____
Date_____
```

Trend data records will be output as follows:

HH:MM:SS	BPM	SpO2
00:00:00	XXX	XXX%
00:00:30	XXX	XXX%
00:01:00	XXX	XXX%
00:01:30	XXX	XXX%
00:02:00	XXX	XXX%

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## Chapter 9: Analog Output

### Analog Out Menu

The **ANALOG OUT** menu allows the user to select parameter, waveform, or calibration data to output on each of two analog output channels. All output data is scaled to the range [0-1Volt].

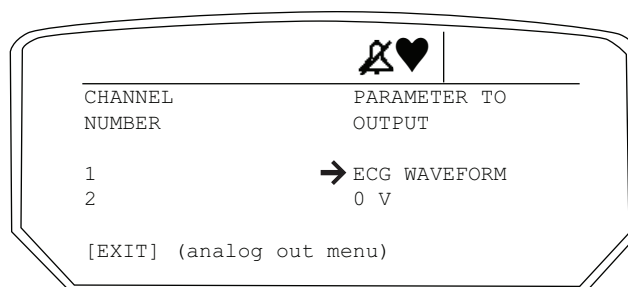





Figure 9.1: Analog Out Menu

To select the data to be output to any analog channel:

1. Select **ANALOG OUT** from the Main Menu.
2. Use the ARROW keys ( ^ v ) to select the channel number **1** or **2**. Then press .
3. Use the ARROW keys ( ^ v ) to select the desired parameter ( **ECG Waveform**, **Plethysmogram**, **%SpO2**, **Heart Rate**, **Resp Rate**, **Temperature**).
4. Press  to accept the value.
5. Select **[EXIT]** or press  to exit the menu.

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## Chapter 10: Routine Maintenance


### Operator's Maintenance

Smiths Medical PM, Inc. Veterinary Division products have been designed to operate continuously for long periods without maintenance. However, in order to ensure a continued high level of performance and safety operation, the routine maintenance information in this section **MUST** be observed.

Routine maintenance should be carried out on site by the operator on a daily basis. A summarized schedule and full details of this level is contained in this section.

ITEM	ACTION	INTERVAL
Battery	Charge.	When LOW BATTERY is displayed. After continuous use under battery power.
The monitor's surface	Clean or disinfect.	As required.
Clean patient connected accessories	Clean or disinfect sensors, Patient cables, ECG leads.	When attaching a new patient.
Check patient connected accessories	Inspect sensors, cables and connectors for signs of damage or deterioration. Replace as required.	Daily.
SpO <sub>2</sub> Sensor (reusable)	Clean or disinfect.	When attaching a new patient.
ECG Electrodes	Disposable: discard after single patient use.	When attaching a new patient.

### Charging the Battery

Charge the battery after the monitor is used under battery operation, when the "**LOW BATTERY**" message is displayed, or after long term storage. Connect the external charger to the back of the monitor. Verify the green LED  is lit. After 5 to 6 hours, the battery is fully charged, indicated by a continuously lit LED.

After connecting the external charger, the unit automatically goes into "fast charge" which is indicated by a flashing green LED. After 3 to 4 hours, the battery is fully charged, indicated by a continuously lit LED.

### Cleaning and Disinfecting

**WARNING! Do not autoclave, ethylene oxide sterilize, or immerse the monitor in liquid.**

**WARNING! Do not allow any moisture to touch the AC power supply connectors or a safety hazard may result. Ensure that hands are thoroughly dry before handling the AC power supply.**

**CAUTION! Do not allow water or any other liquid to be spilled onto the monitor. Unplug the AC power cord from the monitor before cleaning or disinfecting.**


**CAUTION! Where the equipment has been wetted accidentally, it should be wiped dry externally and allowed to dry thoroughly before use.**

Clean the surfaces of the monitor and the accessories with a soft cloth moistened in a mild soap solution. If disinfecting is required, wipe the surfaces with isopropyl alcohol, then wipe with a water moistened soft cloth.

## Long Term Storage

Storage Facility:	Indoor
Temperature:	-40 to +75° C (-40 to +167° F)
Relative Humidity:	10 to 95%, non-condensing
Periodic Inspection:	None required.
Special Procedures:	Store the monitor and accessories in the original packing materials and shipping carton.

## Chapter 11: Troubleshooting

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
Check SpO2 Sensor is displayed.	Sensor not connected to monitor or patient.	Connect the sensor to the patient cable and connect the patient cable to the monitor.
	Sensor improperly positioned on patient.	Reposition the sensor on the patient.
	Incorrect sensor for application.	Choose the correct sensor for the application.
	Defective sensor or patient cable.	Change the sensor or contact Smiths Medical PM, Inc. Veterinary Division service department.
Unit operates when connected to external charger, but not on battery power.	Battery shelf life exceeded.	Contact Smiths Medical PM, Inc. Veterinary Division service department.
Display does not light.	If operating on battery, battery may need charging.	Recharge battery.
Green (charge) LED  not lit.	External charger disconnected.	Connect charger.
No pulse registering on bargraph.	Sensor or patient cable disconnected from monitor.	Check connections to patient cable and sensor.
	Sensor incorrectly positioned.	Reposition sensor on patient.
	Poor patient perfusion.	Reposition sensor on patient.
	Defective sensor or patient cable.	Try a new sensor or contact Smiths Medical PM, Inc. Veterinary Division service department.
Pulse rate erratic, intermittent, or incorrect.	Sensor incorrectly positioned.	Reposition sensor on patient.
	Poor patient perfusion.	Reposition sensor on patient.
	Patient motion.	Patient must be still for monitor to function properly. Place extremity on a pillow, which acts as a "buffer" to motion.
	Ambient light.	Shield with towel.
Lead Off is displayed.	ECG lead(s) not connected to patient cable.	Connect ECG lead(s) to patient cable.
	ECG lead broken (high impedance).	Replace ECG lead.
	Electrode impedance too high.	Reapply electrodes.
ECG electrodes are connected, but no ECG waves or messages are displayed .	The ECG function is disabled.	Use the ECG menu to enable the ECG function.

If the monitor is still not functioning properly, contact Smiths Medical PM, Inc. Veterinary Division service department for help.

Smiths Medical PM, Inc.  
Veterinary Division  
N7W22025 Johnson Drive  
Waukesha, WI 53186-1856

Phone: (262) 513-8500  
Toll Free: (888) 745-6562  
Fax: (262) 513-9069



## Chapter 12: Supplies and Accessories

CAT NO.	DESCRIPTION	QTY.
1606	Simulator, Oximetry/ECG	each
1617	AC Charger, 105 – 125V, 60 Hz	each
1618	AC Charger, 208-264V, 50/60 Hz	each
1619	AC Charger, 90-110V, 50 Hz	each
V1700	Sensor, Oximetry, Reflectance (R/E), Small/Medium	each
V1702	Mini 'Y' Clip	each
V1707	Sensor, Oximetry, Universal "C", Small/Medium	each
V1709	Clip, Replacement for use with Universal "C"	10/pkg
V1710	Tail Wrap Sensor	each
V1711	Large 'Y' Clip	each
V1888	V3404 Operation Manual	each
3049	Adhesive Strips	40/pkg
3106	Cable, ECG, 3 lead	each
V3110	ECG, Shielded leads, 40", safety-type wires, veterinary, 3 lead	each
3311	Cable, Oximetry, 1.5 meters (5 feet)	each
3356	IV Pole Bracket	each
3357	Stack Bracket	each
3361	Cable (Printer) Seiko	each
3362	Cable, PC Interface	each
3368	Roll Stand with Mounting Bracket	each
3371	Graphics Printer Interface	each
3406	Cable, ECG, 5 lead	each
V3411	ECG, Shielded leads, 40", safety-type wires, veterinary, 5 lead	each

For ordering information, contact the customer service department at the address or phone number below:

Smiths Medical PM, Inc.  
 Veterinary Division  
 N7W22025 Johnson Drive  
 Waukesha, WI 53186-1856

Phone: (262) 513-8500  
 Toll Free: (888) 745-6562  
 Fax: (262) 513-9069

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## Chapter 13: Specifications

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### Parameters Monitored

- SpO<sub>2</sub>
- Pulse Rate
- Pulse Strength
- Heart Rate (ECG)
- Pace Pulses

### Graphics Display

- Plethysmogram
- ECG
- Graphics Trend
- Oximetry Bargraph

### SpO<sub>2</sub>

Range:	50-100% SpO <sub>2</sub>
Accuracy:	±2% @ 70-100% SpO <sub>2</sub> ±3% @ 50-69% SpO <sub>2</sub>
Calibration:	Factory calibrated over 50% to 100% SpO <sub>2</sub> using human blood samples to functional saturation. Test methods available upon request. No in-service calibration required.
Alarm Ranges:	Low 50-100% (1% increments), and Off High 50-100% (1% increments), and Off At power up, low %SpO <sub>2</sub> limit will default to 85% if the low %SpO <sub>2</sub> limit was set to less than 85%.
Display:	3-digit 0.56 inch high LED's (update rate = 1 Hz)
Averaging:	4/8/16 (Fast / Normal / Slow) pulse beat average (selectable)
Pleth Sweep:	12.5, 25 or 50 mm/sec.
Sensors:	Red: 660nm, 2mw (typical) Infrared: 905nm, 2-2.4mw (typical)

### Pulse Strength

Range:	0 - 15 bpm, indicates logarithmic strength of patients pulse. Not proportional to pulse volume.
Display:	10 – segment graphics bargraph (update rate = 60Hz) (Display is not proportional to pulse volume)

## Pulse Rate

Range:	20 – 350 bpm
Accuracy:	> of $\pm 2\%$ or $\pm 2$ bpm (20 to 350 bpm)
Alarm Ranges:	Low 20-350 bpm (1 bpm steps) and Off High 20-350 bpm (1 bpm steps) and Off
Display:	3-digit 0.43 inch high LED's (update rate = 1 Hz)
Averaging:	Normal (8 second) or Slow (16 second) average (selectable)

## ECG

Configuration:	3 or 5 lead
Lead Selection:	I, II, III (Standard Limb Lead Configuration), aVR, aVL, aVF and V.
Gain:	X1, X2, X4, X8
Input Range:	-5.0mV to +5.0mV
DC Offset Voltage:	-300mV to +300mV
Frequency Response:	0.5Hz to 40Hz
Input Impedance:	> 5 Mohms differential, as required and tested by ANSI/AAMI EC-13
System Noise, max.:	30 $\mu$ V p-p
CMRR:	100db @ 50/60Hz
Leakage Current:	< 10 $\mu$ A
Patient Isolation:	> 4000VAC
Pace Detect:	Yes (minimum pulse amplitude of 3 mV)
Pace Reject:	Yes
Sweep Speed:	12.5, 25 or 50 mm/sec. (display update rate of 60 Hz)
Selectable 50Hz/60Hz noise filter	Yes
Selectable QRS threshold detection	Yes (0.10mV, 0.12mV, 0.15mV, 0.40mV)

## Heart Rate (ECG)

Range:	20 – 350 bpm
Accuracy:	> of $\pm 2\%$ or $\pm 2$ bpm (20 to 350 bpm)
Alarm Ranges:	Low 20-350 bpm (1 bpm steps) and Off High 20-350 bpm (1 bpm steps) and Off
Display:	3-digit 0.43 inch high LED's (update rate = 1 Hz)
Averaging:	8 seconds (not user selectable)

## Alarms/Alerts/Indicators

Limit Exceeded or Matched:	SpO <sub>2</sub> and Pulse Rate, associated display will flash ON and OFF, red ALARM LED will flash, Audible will sound (if not silenced) LOW or HIGH and the parameter in violation will be displayed in the message area.
ASYSTOLE Alarm:	ALARM LED will flash, Audible will sound (if not silenced), ASYSTOLE message on graphics screen to flash
Audio Disabled:	SILENCED BELL icon (displayed on EL) indicates temporary or indefinite status
SpO <sub>2</sub> Sensor:	SpO <sub>2</sub> Sensor message indicates an oximeter sensor problem, Audible will sound (if not silenced), yellow ALERT LED continuously lit.
SpO <sub>2</sub> Search:	SpO <sub>2</sub> SEARCH message indicates that device is searching for pulse
Artifact:	ARTIFACT message informs operator about excess of artifacts
ECG/Lead Fail:	ECG LEAD FAIL message indicates a lead off condition or ECG amplifier overload, yellow ALERT LED is on continuously, Audible will sound (if not silenced)
Charge:	Green CHARGE LED indicates external power and battery is charging
Low Battery:	LOW BATTERY message indicates battery operation has approximately 10 minutes remaining and should be charged, audible 5 beep burst will sound
Pace Detect:	A line will be drawn on the screen when a pace maker signal is detected.

## I/O's

SpO <sub>2</sub> Sensor:	DB-9 connector with locking mechanism, compatible with all SurgiVet® oximeter sensors
ECG Patient Cable:	AAMI 6-pin connector
Power:	standard DC power supplied by wall mount or table top unregulated AC adapter
Serial/Analog:	RS232C (DB-9 pin) serial output of data, 9600 baud, 8 bits. Also connects to optional digital (remote alarm) interface. Two analog outputs can be configured to any of the parameters monitored.

## Optional Printer and Serial Interface

A graphics printer output is available. It runs in either of the following modes, and is controlled by the Start/Stop key on the printer panel.

The connection will be a serial one with the following settings: 9600bps, No parity, 8 data bits, 1 stop bit.

Data Log Mode:	When this mode is set through menu, every 5 sec data line is sent out. Data line includes SpO <sub>2</sub> , Pulse Rate (Heart Rate) and Signal Strength.
Trend Printing:	When this mode is set through menu, trend data is sent with a speed defined by the CTS return line (defined by printer or computer).
Waveform Printing:	The user will be able to print a real time plot of ECG and/or a Plethwave
Generic Printing:	There will be the option to send text data to any RS-232 port.

## Trend Storage

Parameters:	SpO <sub>2</sub> , Pulse Rate (Heart Rate) and Signal Strength
Interval:	30 sec non-adjustable
Capacity:	21 hours of storage

## Sound Control

Pulse Beep Volume:	15 levels of volume and off
Alarm Beep Volume:	15 levels of volume and silenced
Sound level :	less than 85dBA.

## Brightness Control

None

## Analog Outputs

Channels:	Two, configurable through menu
Range:	0 to 1 VDC
Differential Accuracy :	$\pm 10\text{mV}$
Output Offset:	+40/-0 mV
Max. Load:	3k Ohm, 500pF

## Digital Alarm Output to Remote Sensing Location - Nurse Call

Configuration:	Optional, attached and powered by communication port
Output:	DC switch (MOSFET)
Max. voltage:	24 VDC
Max. load current:	0.5 A continuous, 5 A peak
Max. On resistance:	0.15 Ohm

## Power

Battery:	1 to 1.5 hours of continuous operation max. charge time 6 hours.
External:	12VDC @ 1A provided by external wall mount transformer with 4kV isolation

## Environment

Temperature:	Operating: 0°C to 55°C Storage: -40°C to +75°C
Relative Humidity:	Operating: 15 to 95% (non-condensing) Storage: 10 to 95% (non-condensing)
EMC:	As per the most recent FDA reviewer guidance for respiratory devices and EN60601-1-2
Safety:	IEC 601-1, CSA 125, UL 544 and UL2601







## Physical

Size:	
Width:	254 mm (10 inches)
Height:	88.9 mm (3.5 inches)
Depth:	139.7 mm (5.5 inches)
Weight:	Approximately 2.27 kg (5.0 pounds)
Handle on top for portability	

## Display

- Six LED displays
- Green CHARGE LED
- Red High Priority ALARM LED
- Yellow Low Priority ALARM LED
- 160 by 80 pixels EL (Electroluminescent) graphics panel.

## Keypad

- Device ON/OFF 
- Menu / Enter 
- Alarm Silence 
- UP arrow 
- DOWN arrow 
- Wave / Trend 

## List of Applicable Standards

- EN60601-1/IEC601-1/UL2601/CSA601-1
- Reviewer's Guidance, NOV. 93
- EN60601-1-2 (EMC)
- IEC601-2-27 (ECG)
- AAMI EC-13 (ECG)
- EN865 (SpO2)
- EN475 (alarms)
- prEN1441 (risk analysis)
- HE48 Human Factors AAMI Standard

## Equipment Classification

Type of Protection:	Class II with functional ground & Internally Powered
Degree of Protection:	Type CF (SpO <sub>2</sub> )
(Against Electric Shock)	Type CF defib protected (ECG)
Mode of Operation:	Continuous
Degree of Protection:	IPX1, drip proof (Against Ingress of Liquids)
Degree of Mobility:	Portable
Safety Requirements:	EN60601-1: 1990

## Calibration

Factory calibrated over the range of 50% to 100% SpO<sub>2</sub>. All accuracy claims are based on testing the subject monitor on healthy adult volunteers in desaturation studies across the specified range of functional saturation. Test methods will be made available upon request. No in-service calibration is required.



## Appendix A: Guidance and Manufacturer's Declaration

### Guidance and Manufacturer's Declaration

The V3404 is intended for use in the electromagnetic environment specified in the tables within this appendix.

**NOTE! The customer or user of the V3404 should ensure that it is used in such an environment.**


### Electromagnetic Emissions - Emissions Test

EMISSIONS TEST	COMPLIANCE	ELECTROMAGNETIC ENVIRONMENT GUIDANCE
RF emissions CISPR 11	Group 1	The V3404 uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.
RF emissions CISPR 11	Class B	The V3404 is suitable for use in all establishments, including: <ul style="list-style-type: none"> <li>• Domestic establishments.</li> <li>• Establishments directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.</li> </ul>
Harmonic emissions IEC 61000-3-2	NA	
Voltage fluctuations/ flicker emissions IEC 61000-3-3	NA	

### Electromagnetic Emissions – Immunity

IMMUNITY	ELECTROMAGNETIC ENVIRONMENT GUIDANCE
Electrostatic discharge (ESD) IEC 61000-4-2	<div>IEC 60601 TEST LEVEL</div> <ul style="list-style-type: none"> <li>• <math>\pm 6</math> kV contact</li> <li>• <math>\pm 8</math> kV air</li> </ul> <div>COMPLIANCE LEVEL</div> <ul style="list-style-type: none"> <li>• <math>\pm 2</math> kV contact</li> <li>• <math>\pm 8</math> kV air</li> </ul>
	Floors should be made of: <ul style="list-style-type: none"> <li>• Wood</li> <li>• Concrete</li> <li>• Ceramic tile</li> </ul> If floors are covered with synthetic material, the relative humidity should be at least 30%.

IMMUNITY		ELECTROMAGNETIC ENVIRONMENT GUIDANCE
Electrical fast transient/ burst IEC 61000-4-4	<b>IEC 60601 TEST LEVEL</b>	A.C. Mains power voltage should be the typical quality of a: <ul style="list-style-type: none"><li>• Commercial environment.</li><li>• Hospital environment.</li></ul>
	<ul style="list-style-type: none"><li>• ±0.5 kV to ±2 kV for power supply lines.</li><li>• ±0.25kV to ±1 kV for input/output lines.</li></ul>	
	<b>COMPLIANCE LEVEL</b>	
	<ul style="list-style-type: none"><li>• ±0.5 kV to ±2 kV for power supply lines.</li><li>• ±0.25 kV to ±1 kV for input/output lines.</li></ul>	
Surge IEC 61000-4-5	<b>IEC 60601 TEST LEVEL</b>	
	<ul style="list-style-type: none"><li>• ±1 kV differential mode</li><li>• ±2 kV common mode</li></ul>	
	<b>COMPLIANCE LEVEL</b>	
	<ul style="list-style-type: none"><li>• ±1 kV differential mode</li><li>• ±2 kV common mode</li></ul>	
Voltage dips, short interruptions, and voltage variations on power supply input lines IEC 61000-4-11	<b>IEC 60601 TEST LEVEL</b>	
	<ul style="list-style-type: none"><li>• &lt;5% <math>U_T</math> (&gt;95% dip in <math>U_T</math>) for 0.5 cycle.</li><li>• &lt;40% <math>U_T</math> (&gt;60% dip in <math>U_T</math>) for 5 cycles.</li><li>• &lt;70% <math>U_T</math> (&gt;30% dip in <math>U_T</math>) for 25 cycles.</li><li>• &lt;5% <math>U_T</math> (&gt;95% dip in <math>U_T</math>) for 5 seconds.</li></ul>	
	<b>COMPLIANCE LEVEL</b>	
	<ul style="list-style-type: none"><li>• &lt;5% <math>U_T</math> (&gt;95% dip in <math>U_T</math>) for 0.5 cycle.</li><li>• &lt;40% <math>U_T</math> (&gt;60% dip in <math>U_T</math>) for 5 cycles.</li><li>• &lt;70% <math>U_T</math> (&gt;30% dip in <math>U_T</math>) for 25 cycles.</li><li>• &lt;5% <math>U_T</math> (&gt;95% dip in <math>U_T</math>) for 5 seconds.</li></ul>	
Note: $U_T$ is the A.C. mains voltage prior to application of the test level.		

IMMUNITY		ELECTROMAGNETIC ENVIRONMENT GUIDANCE
Power frequency (50/60 Hz) IEC 61000-4-8	<b>IEC 60601 TEST LEVEL</b>	Power frequency magnetic fields should be the typical levels of a: <ul style="list-style-type: none"><li>• Commercial environment</li><li>• Hospital environment</li></ul>
	3 A/m	
	<b>COMPLIANCE LEVEL</b>	
	3 A/m	
Conducted RF IEC 61000-4-6	<b>IEC 60601 TEST LEVEL</b>	<b>Recommended separation distance:</b>  $d = 1.2$
	<ul style="list-style-type: none"><li>• 3 V rms</li><li>• 150 kHz to 80MHz</li></ul>	
	<b>COMPLIANCE LEVEL</b>	
	<ul style="list-style-type: none"><li>• 3 Vrms 80% AM modulation @ 0.5Hz</li><li>• 150 kHz to 80 MHz.</li></ul>	
Radiated RF IEC 61000-4-3	<b>IEC 60601 TEST LEVEL</b>	<b>Recommended separation distance:</b>  $d = 0.35 \sqrt{P}$ 80 MHz to 800 Mhz  $d = 0.70 \sqrt{P}$ 800 MHz to 2.5 GHz
	<ul style="list-style-type: none"><li>• 3 V/m</li><li>• 80 MHz to 2.5 GHz</li></ul>	
	<b>COMPLIANCE LEVEL</b>	
	<ul style="list-style-type: none"><li>• 10 V/m 80% AM</li><li>• 80 MHz to 1.0 GHz</li></ul>	
<ul style="list-style-type: none"><li>• <math>P</math> = Manufacturer's output power in watts (W).</li><li>• <math>d</math> = Recommended distance in meters (m).</li></ul>		
Field strengths from fixed RF transmitter, as determined by an electromagnetic site survey <sup>a</sup> , should be less than the compliance level in each frequency range. <sup>b</sup>		
<b>CAUTION! Interference may occur in the vicinity of equipment marked with the following symbol:</b> 		
<i>Note: At 80 MHz and 800 MHz, the higher frequency range applies.</i>		
<i>Note: These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.</i>		
<sup>a</sup> Field strengths from fixed RF transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the V3404 is used exceeds the applicable RF transmitter compliance level above, the V3404 should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as reorienting or relocating the V3404.		
<sup>b</sup> Over the frequency range 150 kHz to 80 MHz, field strengths should be less than 3 V/m.		

## Recommended Separation Distances

The V3404 is intended for use in an electromagnetic environment where radiated RF disturbances are controlled. The customer or the user of the V3404 can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the V3404 as recommended below, according to the maximum output power of the communications equipment.

The recommended separation distances between portable and mobile RF communication equipment and the V3404 is:

RATED MAXIMUM OUTPUT POWER OF RF TRANSMITTER (WATTS)	SEPARATION DISTANCE ACCORDING TO THE FREQUENCY OF RF TRANSMITTER (METERS)		
	150 kHz to 80MHz $d = 1.2\sqrt{P}$	80 MHz to 800 MHz $d = 1.2\sqrt{P}$	800 MHz to 2.5 GHz $d = 2.3\sqrt{P}$
0.01	0.12	0.035	0.07
0.1	0.38	0.11	0.22
1	1.2	0.35	0.7
10	3.8	1.1	2.2
100	12	3.5	7.0
For transmitters rated at a maximum output power not listed above, the recommended separation distance $d$ in meters (m) can be determined using the equation applicable to the frequency of the transmitter, where $P$ is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.			
<i>NOTE: At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies.</i>			
<i>NOTE: These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.</i>			

**WARNING! The monitor should not be used adjacent to or stacked with other equipment. If adjacent or stacked use is necessary, the monitor should be observed to verify normal operation in the configuration in which it will be used.**

## Appendix B: Revision History

REVISION	DATE	CHANGES
Rev. 4	August, 2007	<ul style="list-style-type: none"> <li>• Changed company logo and added manufacturer's address to back cover.</li> <li>• Added patent and trademark information to table of contents.</li> <li>• Updated warranty statement.</li> <li>• Updated symbol chart in Chapter 1.</li> <li>• Changed some cautions and notes to warnings</li> <li>• Added AC power warnings.</li> <li>• Added warning to verify that all LEDs on the display light up upon startup of the device.</li> <li>• Added warning about incorrectly applied sensors.</li> <li>• Added photodynamic therapy warning.</li> <li>• Added warning about the oximeter displaying dashes or erroneous values under certain conditions.</li> <li>• Added caution about certain cleaning agents causing brittle plastic.</li> <li>• Added notes about alarm limits being retained through power cycles to Chapter 4.</li> <li>• Added note about testing the alarms while the monitor is in use.</li> <li>• Updated Pulse Oximetry Theory of Operation in Chapter 6.</li> <li>• Added paragraph about autocorrelation to Chapter 6.</li> <li>• Added notes about SpO<sub>2</sub> averaging.</li> <li>• Updated sensor chart in Chapter 6.</li> <li>• Updated sensor sections in Chapter 6.</li> <li>• Added Checking the Oximeter's Performance section to chapter 6.</li> <li>• Added note about trend data being remembered at power down to Chapter 7.</li> <li>• Updated parts list in Chapter 12.</li> <li>• Update ECG Input Impedance in Chapter 13.</li> <li>• Updated line art.</li> </ul>

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